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ABSTRACT

In an effort to provide science teachers with the tables and scales most often used in teaching earth science, this document was designed to coordinate each table with meaningful activities, projects and experiments. The major areas covered by the booklet are: (1) electromagnetic waves (with activities about light waves and sound waves); (2) the earth's crust (including instruction on minerals, earthquakes, and volcanoes); (3) winds and weather (containing tabulations of relative humidity, wind speed and direction, temperature, air pressure, clouds, sky symbols, weather maps, and time); and (4) the solar system (providing instructions on making solar system models and tabulating solar system facts). Included are guides for making simple measurement equipment, along with reproducible handouts, quizzes, and an answer key. (TW)

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ED279531

A Good Apple Science Activity Book for Grades 5-8+

SUPERIFIC SCIENCE

Book X

Learning About Earth Science: Tables and Tabulations

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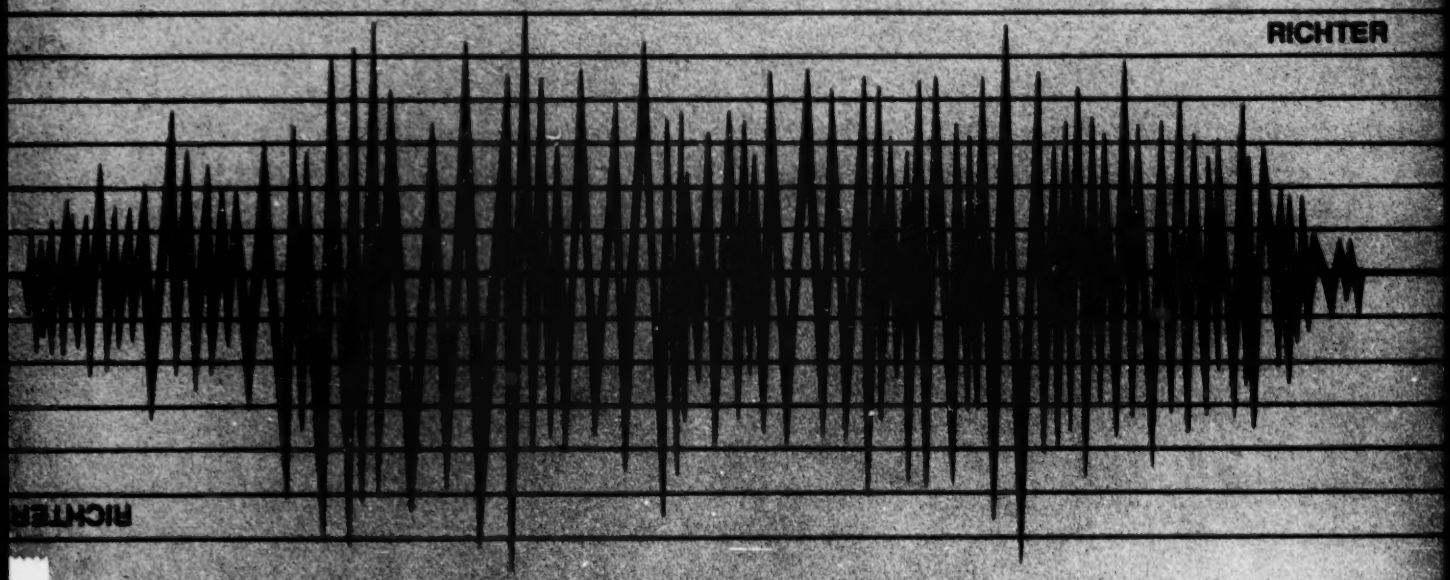

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Written by Lorraine Conway
Illustrated by Linda Akins

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Earth Science:

Tables and Tabulations

Written by **Lorraine Conway**

Illustrations by **Linda Akins**

Cover by **Mark Austin**

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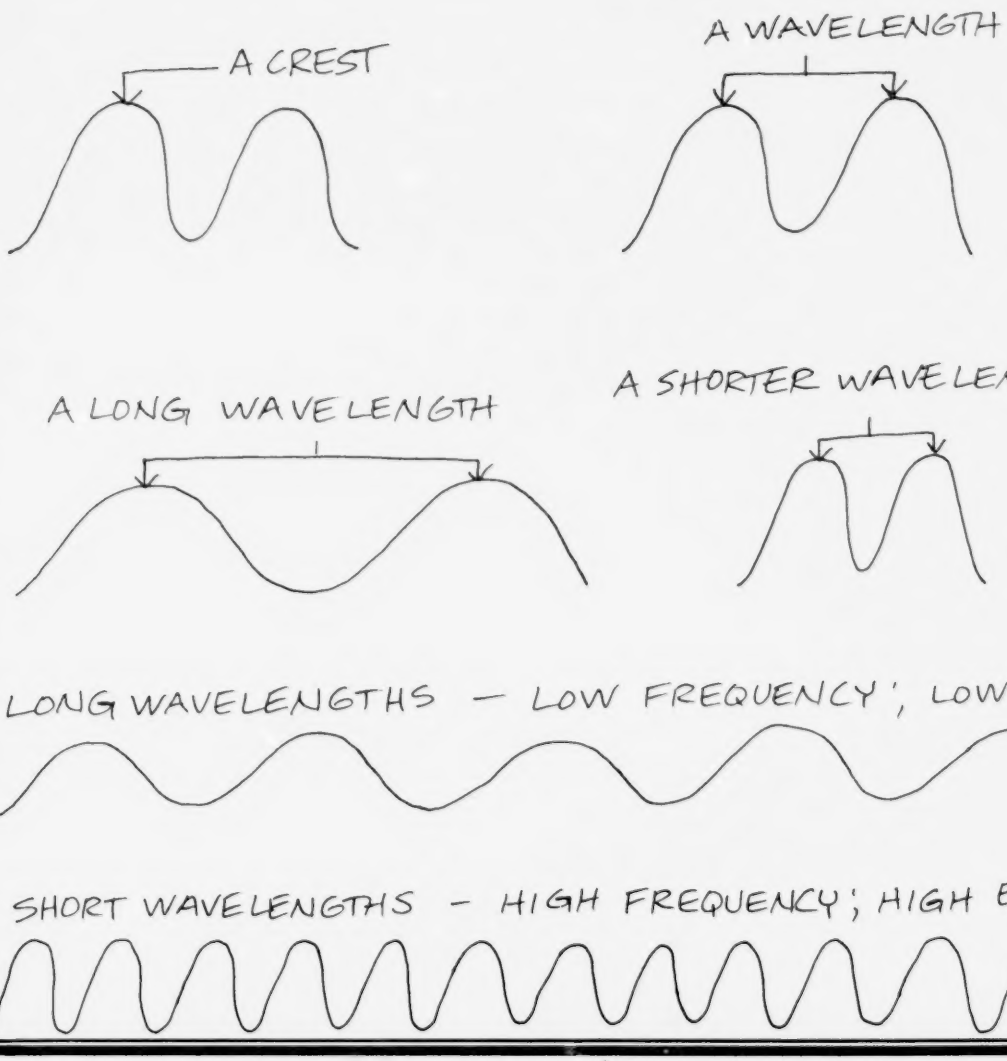
Introduction

Earth Science: Tables and Tabulations employs a novel approach to the teaching of science with the aid of the most often used tables and scales in earth science. Each table is explained and coordinated with meaningful activities, projects and experiments that bring the contained information to life. The main areas of concentration are: electromagnetic waves, the earth's rocks, winds and weather, and the solar system.

In *Earth Science: Tables and Tabulations* science teachers will find having all the tables and scales for teaching science in one book an enormous time saver, and science students will explore the meanings and uses of science tables in a challenging and interesting fashion.

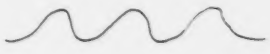
Electromagnetic Waves

What do a radio, a stove, the sun and an x-ray machine have in common? If your answer is that they all transmit their energy in the same way, you are correct. All of them transmit energy by means of electromagnetic waves. Two properties of electromagnetic waves are frequency and length. The frequency of an electromagnetic wave is the number of waves that pass a certain point in a second. Frequency is measured in units called hertz. Wavelength is the distance from one wave crest to the next. Wavelengths are measured in units called angstroms. The longest electromagnetic waves are hundreds of miles long; the shortest are less than a billionth of an inch. Cosmic waves and gamma waves are very short; radio waves are long. When a wave is long its frequency and energy are lower; short wavelengths have higher frequencies and greater energy.


A CREST
A WAVELENGTH
A LONG WAVELENGTH
A SHORTER WAVELENGTH
LONG WAVELENGTHS — LOW FREQUENCY; LOW ENERGY
SHORT WAVELENGTHS - HIGH FREQUENCY; HIGH ENERGY.

Electromagnetic Waves

1. Which wave has the higher energy?

a.  b.

2. Which wave has the longest wavelength?

a. b.

3. Which wave has the lower energy?

a. b.

4. Which has the higher frequency?

a. b.

5. Two properties of electromagnetic waves are _____ and _____.

6. Frequency is measured in units called _____.

7. Wavelengths are measured in units called _____.

8. Two examples of short waves are _____ and _____.

9. An example of a long wave is _____.

10. Long waves have _____ frequencies and energy; short waves have _____ frequencies and energy.

ALTERNATING CURRENT

RADIO WAVES

RADAR (USED BY SHIPS AT SEA)

MICROWAVES (RAPID COOKING)

INFRARED RAYS (HEATING LAMPS)

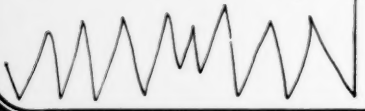
VISIBLE LIGHT (VISIBLE RADIANT ENERGY)

ULTRAVIOLET RAYS (CAUSE SUNBURN)

X-RAYS (USED FOR BONE PICTURES)

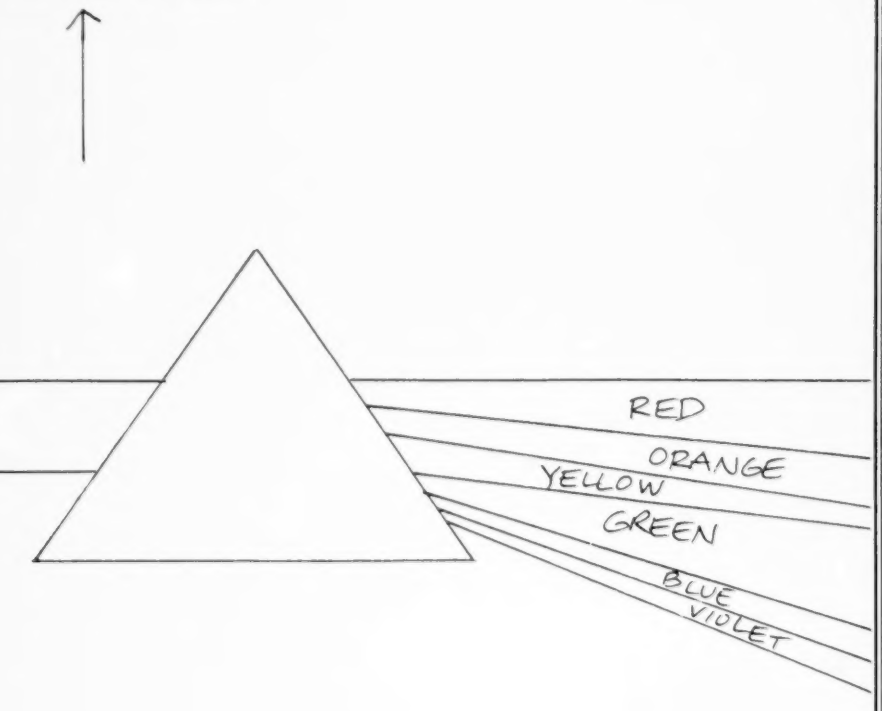
GAMMA RAYS (HIGH ENERGY RAYS AS IN RADIOACTIVE RADIUM)

COSMIC RAYS (OUTER SPACE)



The part of the electromagnetic spectrum which our eyes can see is very small, only 3%. We call this part of sunlight that our eyes detect visible radiant energy; it ranges in color from red to violet.

LOW FREQUENCY
LOW ENERGY



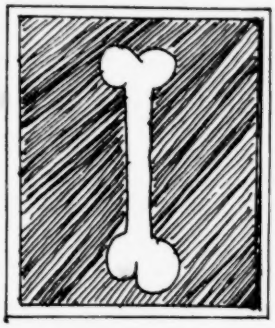
Use a prism to show the colors of visible light rays, the only rays our eyes detect. Color the rays of the spectrum as indicated. Which rays are the longest? Which rays are the shortest?

HIGH FREQUENCY
HIGH ENERGY

Tabulating Electromagnetic Waves

Each of the following drawings should suggest a type of electromagnetic wave. Can you match each drawing to the name of the wave?

a. x-ray
b. microwaves
c. radio waves
d. visible light waves
e. gamma rays
f. ultraviolet rays
g. cosmic ray
h. infrared waves
i. radar waves



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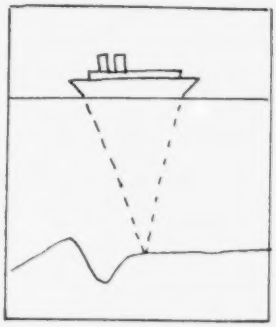

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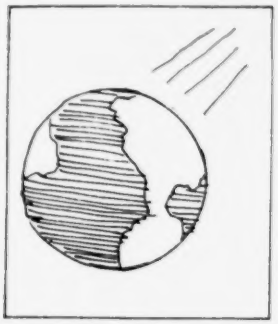

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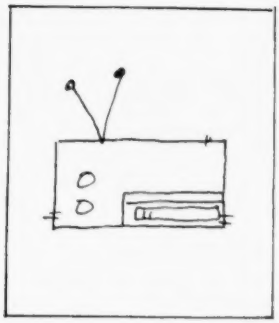

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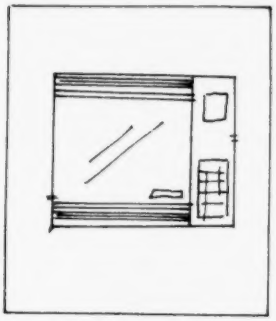

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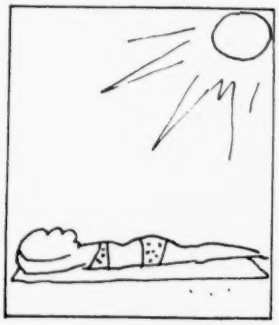

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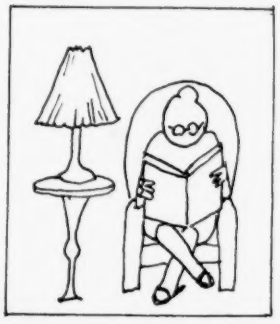

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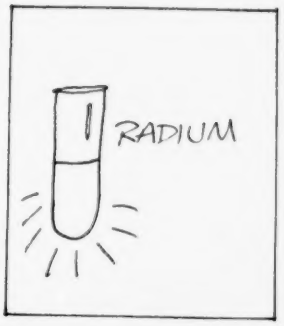

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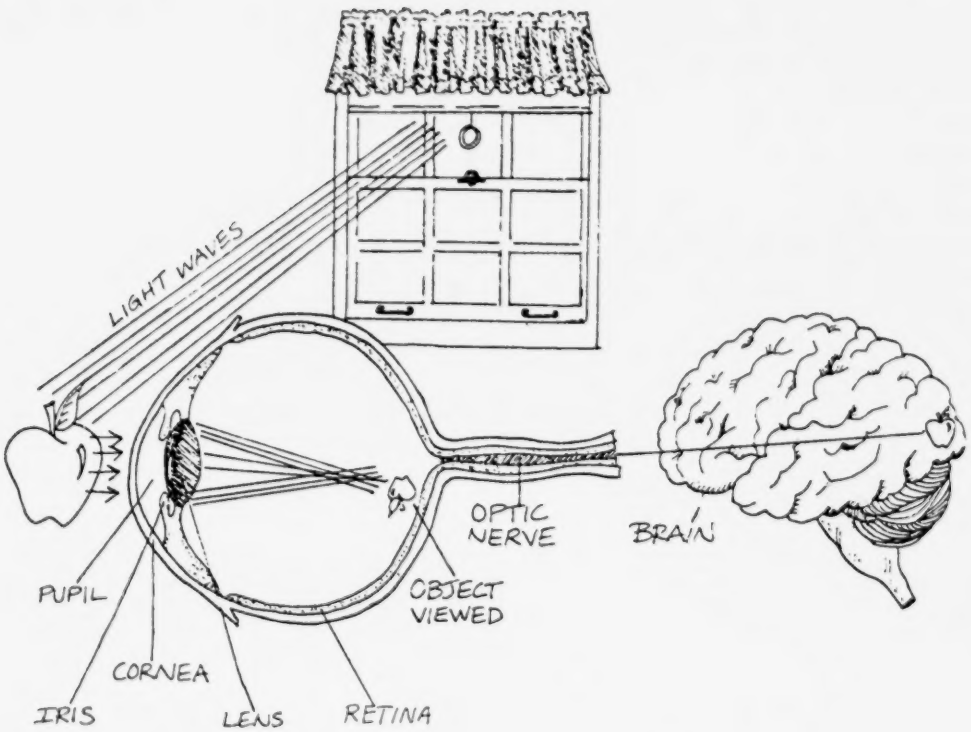
Light Waves and How We See



In order to see, there must be light. Animals which live in caves or in the depths of the sea where there is no light are either blind or have no eyes at all. We see as a result of the reflection of light rays from a viewed object to our eye. These rays first pass through the transparent cornea and then through the pupil. Next they are brought into focus and turned upside down by the lens. When the rays reach the light-sensitive cells of the retina, an upside-down image of the object being viewed is produced. The optic nerve conveys this message to the brain where it is turned rightside up and interpreted by the brain.

Questions on How We See

1. List the main parts of the eye:

   a. _____

   b. _____

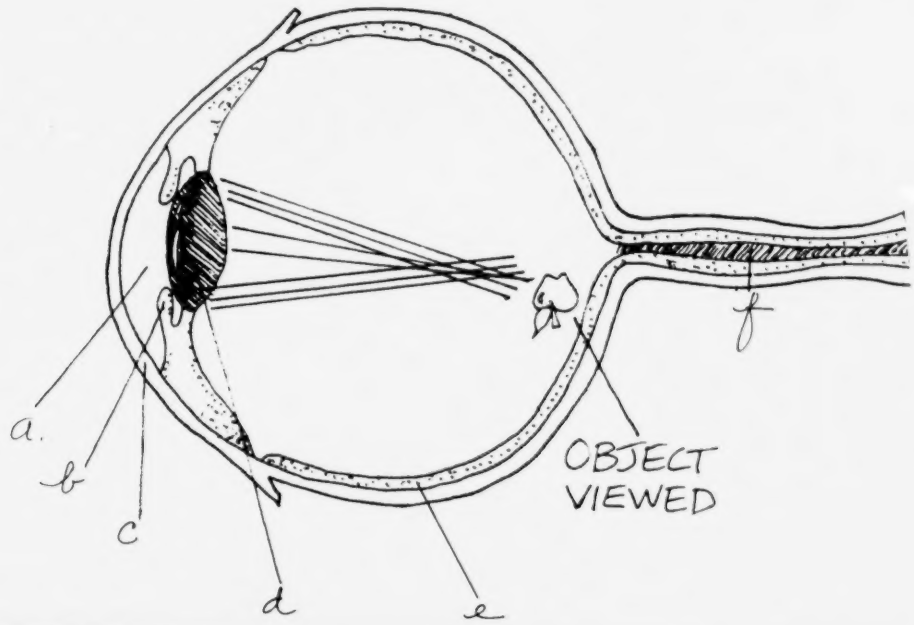
   c. _____

   d. _____

   e. _____

   f. _____

2. What part of the eye focuses the viewed object?
3. On what part of the eye is the viewed object produced?
4. What nerve conveys sight messages to the brain?
5. What part of the eye turns the viewed object upside down?
6. Where is the viewed object turned rightside up again?
7. What must be present in order to see?
8. Where on the eye are the light-sensitive cells located?
9. Do all animals have eyes?
10. What part of the eye is transparent?



A Table for Sound

Sound is caused by vibration or movement; it travels in waves through various mediums of solids, liquids and gases. Sound is measured in units called decibels (*deci* meaning 1/10 and *bel* for Alexander Graham Bell) by an instrument called a sound meter. The faintest sound the human ear can detect is 0 on the decibel scale; at the top of the scale, 130 decibels, sound is painful to the human ear.

It is now generally agreed that unwanted sound, or noise, is greater than ever, and studies are being conducted to determine its effects. Some health hazards of noise are physical and psychological damage. Among the hearing impaired 16,000,000 are believed to have hearing losses due to avoidable noise-related causes. The more intense the noise, the sooner permanent hearing loss will occur. Damage to human hearing begins at 75-80 decibels; most work environments produce exposure to 90 decibels. If you need to shout to be heard, you are in an environment of 90 decibels or above.

Decibel Scale for Sound

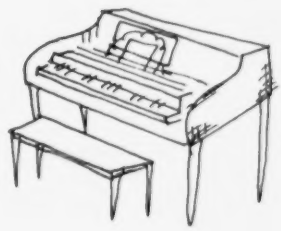
DECIBELS	EFFECT
140	Permanent damage to human ears
130	Painful to human ears
120	Jet airplane taking off at 500 feet
110	Rock band, motorcycle revving up
100	Subway train, electric blender
90	Heavy traffic, shouting
80	Radio turned up, TV Damage to ears begins
70	Piano, office, 3 or 4 people working
60	Conversation, ordinary household
50	Quiet conversation
40	Radio playing softly
30	Whisper, turning pages of book, cat purring loudly
20	Very quiet sounds, cat purring softly
10	Extremely quiet sounds
0	Minimum hearing level for humans

Tabulating Sounds

Rate each of the following situations for its sound in decibels. Situations which produce sounds above 75-80 decibels begin to damage human hearing; write those decibel ratings in red.

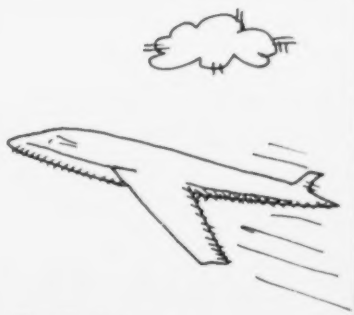
Decibel rating ____

Decibel rating ____



Decibel rating ____

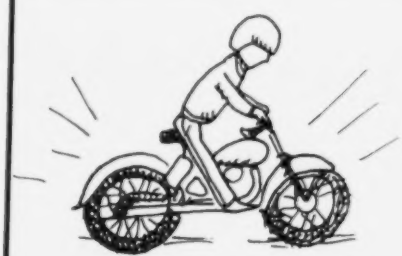
Decibel rating ____



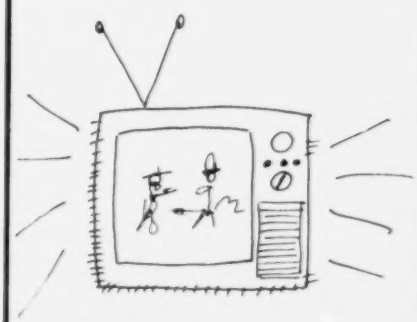
Decibel rating ____

Decibel rating ____

Decibel rating ____



Decibel rating ____



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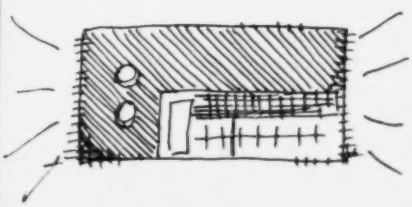

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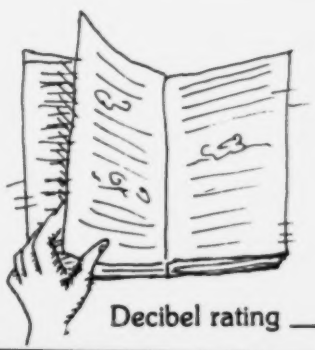
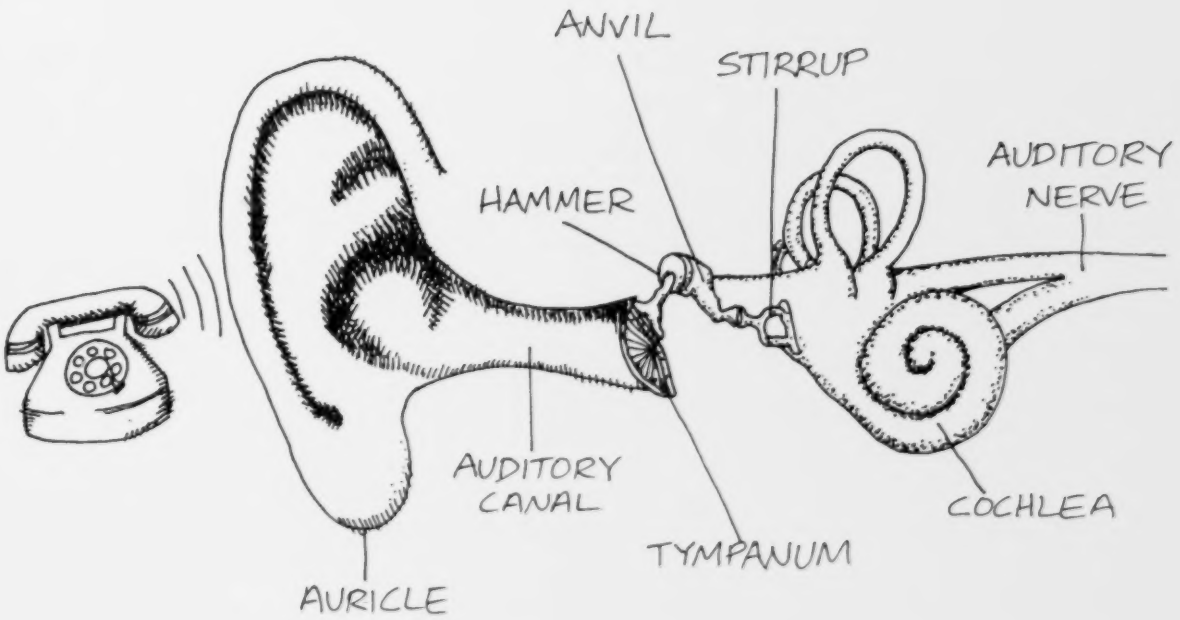


Decibel rating ____

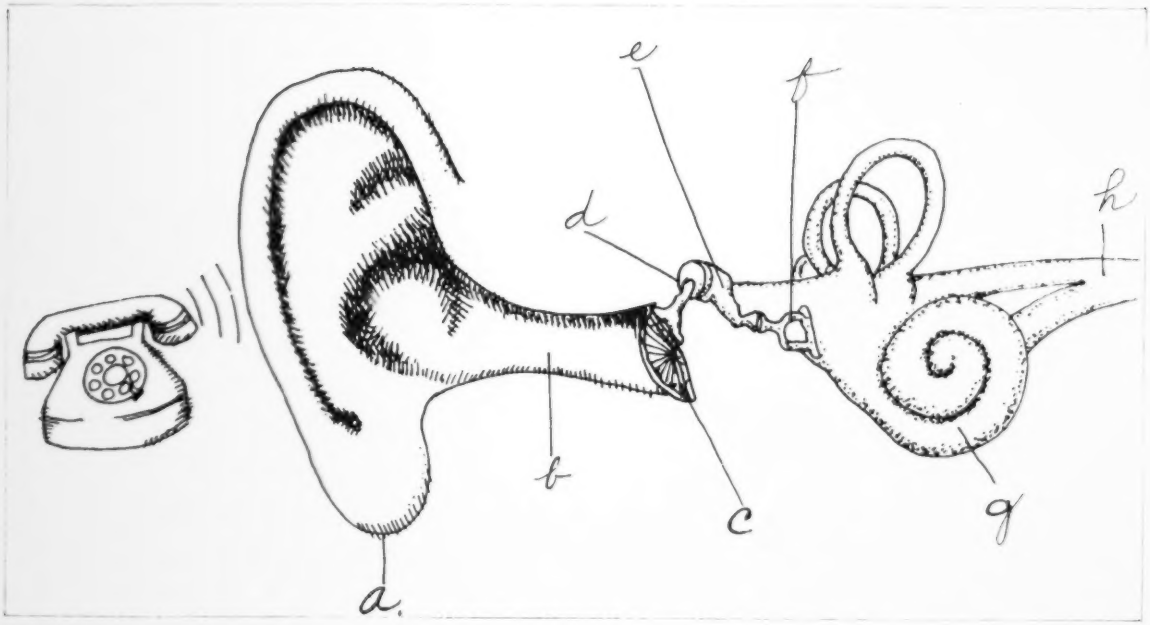
Decibel rating ____

Sound Waves and How We Hear



Vibrating or moving objects send out sound waves which travel through the air to our ears. The shell-like shape of the outer ear (auricle), catching the sound waves, reflects them into the auditory canal which leads to the eardrum (tympanum). The sound waves cause the sensitive eardrum to vibrate, and it in turn vibrates three tiny bones: the hammer (malleus), the anvil (incus), and the stirrup (stapes). The stirrup transfers the vibrations to the cochlea, a snail-shaped organ filled with liquid. The motion of the fluid starts impulses in the sensory cells of the cochlea. These impulses are sent to the sensory nerves leading to the auditory nerve. The auditory nerve relays the impulses to the brain where they are interpreted.

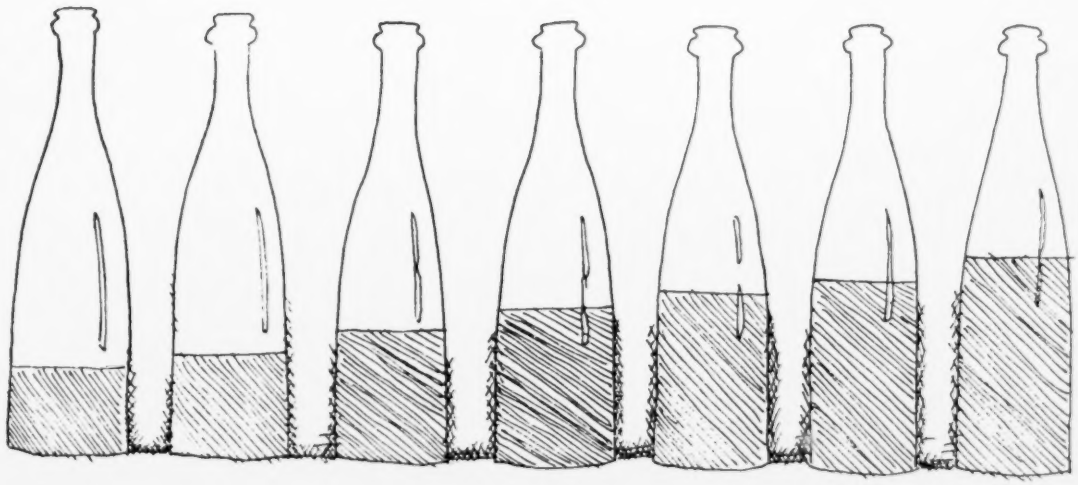
Questions on How We Hear



1. List the main parts of the ear:
   a. _____ e. _____
   b. _____ f. _____
   c. _____ g. _____
   d. _____ h. _____
2. What part of the ear captures the sound waves?
3. What is another name for the eardrum?
4. What are the three tiny bones of the ear called?
5. What is another name for moving objects?
6. What nerve carries sound messages to the brain?
7. Where is sound interpreted and understood by us?
8. What is another name for the outer ear?
9. Most sound waves travel to our ears by what means?
10. Where do sound waves start impulses in our ears?

Soda Bottle Sounds

This activity will show how the length of a column of air affects the sound produced.



MATERIALS: Eight soda bottles, a pitcher of water.

PROCEDURE: Fill the eight soda bottles with increasing amounts of water as shown in the illustration. Blow across the tops of the bottles to produce musical notes. Add or remove water to produce the eight musical notes in a scale. The shorter the column of air, the higher the pitch. Try to play a tune.

VARIATION: You can make your "orchestra" portable by using test tubes in a test tube rack.

Mohs' Scale for Hardness of Minerals

One way to classify and identify minerals is to measure their hardness. There are many scientific and precise ways to do this; however, for students' purposes the Mohs' scale can be very informative and useful. This scale was devised in 1822 by a German mineralogist, Friedrick Mohs. It is so simple and practical that it is still widely used.

In the Mohs' scale, minerals are rated 1 to 10, 1 being the softest and 10 the hardest. The hardness of a mineral can be tested by scratching it with substances of known hardness; a fingernail for example has a known hardness of about 2.5, a copper penny 3, a piece of glass 5.5, a steel knife blade 5.5, and a steel file 6.5. A diamond is the hardest of all substances and has a hardness of 10. Any mineral on the Mohs' scale scratches all minerals with a lower number on the scale and is scratched by minerals with a higher number. Apatite, number 5 on the Mohs' scale, can scratch minerals 4,3,2 and 1, but is itself scratched by minerals 6, 7, 8, 9, and of course, number 10, a diamond.

Number	Mineral	Test
1	Talc	Scratched by fingernail
2	Gypsum	Scratched by fingernail
3	Calcite	Scratched by copper penny
4	Flourite	Scratched by steel knife or file
5	Apatite	Scratched by steel knife or file
6	Feldspar	Scratches glass
7	Quartz	Scratches steel and glass
8	Topaz	Scratches quartz
9	Corundum	Scratches topaz
10	Diamond	Scratches all

Testing the Hardness of Minerals

PURPOSE: To test some common materials for their hardness; to make a rating scale of materials similar to Mohs' scale of minerals.

MATERIALS: A piece of glass, such as window glass with all sharp edges except one taped, your own fingernails, a copper penny, a steel knife, a steel file, samples of rocks and minerals, chalk, piece of a clay flowerpot, variety of plastics, graphite from a lead pencil, bone, seashells, extracted teeth, etc.

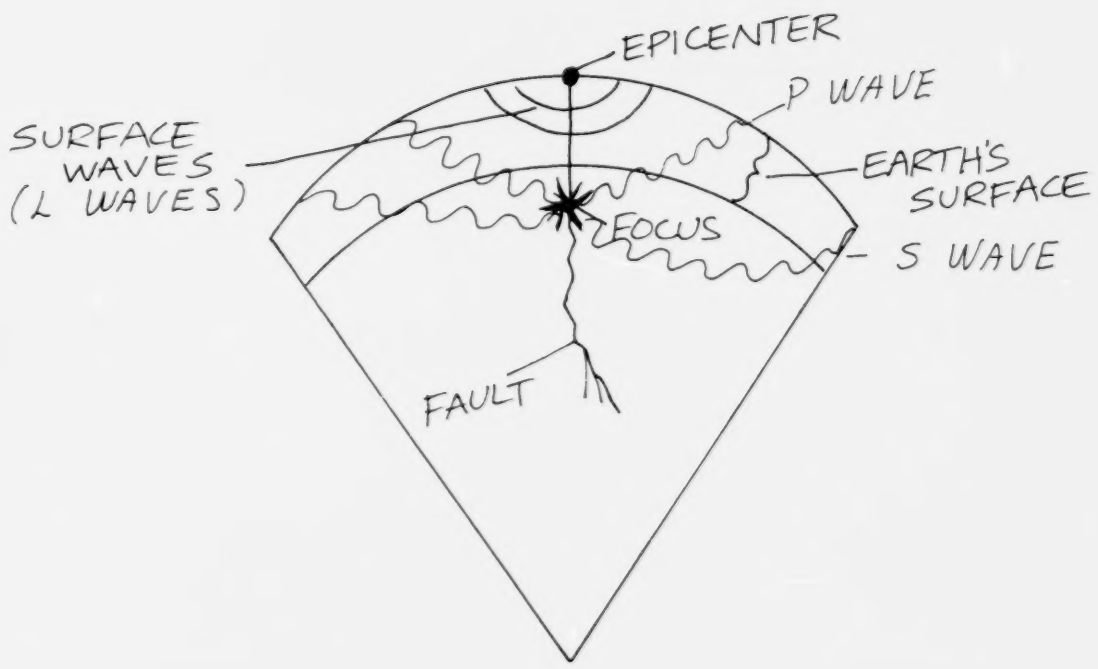
PROCEDURE: First test the materials with your fingernail; those minerals which are scratched by it will be rated below 2.5; next test the remaining minerals with a copper penny (3); continue with a steel knife (5.5) and a steel file (6.5). Now determine which materials scratch other materials. Rate a material above all substances which it scratches and below substances by which it is scratched. Make a table listing the materials tested and your determination of their hardness. Make a display by attaching your minerals to a piece of cardboard or plywood.

Tabulations for Hardness of Minerals

ITEM TESTED	RATING	TEST USED
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

Earthquakes

The movement of the rock on the earth's surface is called an earthquake. The shaking, rolling and vibrating are usually due to the movement of rock along the sides of a fault, or crack, in the earth's surface. The interior of the earth is very hot with temperatures of about 1800° at a depth of 100 miles; because of this, great pressures can be brought upon the layers of rock near the surface. As the pressure builds up, it gradually bends and stretches the rocks until a weak spot is found, resulting in an earthquake. The vibrations coming from an earthquake are known as waves that go in all directions as ripples do in a pond when a stone has been cast into the water. The site of the earthquake is known as the focus, and the waves are classified as three kinds: the primary or P wave, the fastest wave which pushes and pulls the rock as it passes, the secondary or S wave which shakes the rocks as it passes. Both the P and the S waves travel deep into the inside of the earth as they pass. The third type of wave is the long or L wave, which is the slowest wave and travels only along the surface.



The Richter Scale for Measuring Earthquakes

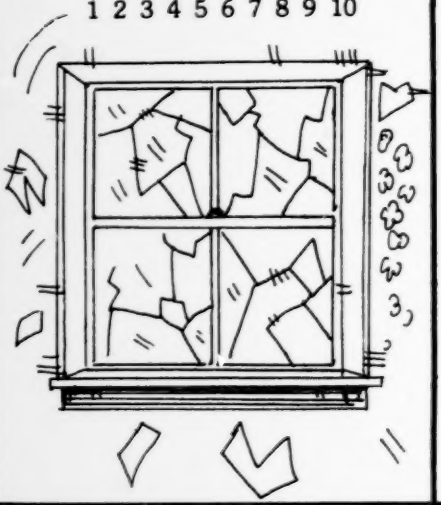
In 1935, a scientist, Charles Richter devised a way to rate the intensity of earthquakes by the use of a scale of 1 to 10, the number 1 indicating the least amount of energy released. As the scale numbers go up, each number indicates an increase in magnitude of 10 times the number below it; a number 3 rating on the scale is 10 times more powerful than a number 2 earthquake on the Richter scale.

NUMBER	RESULTING EFFECTS
0	Smallest vibrations; detected only on the seismograph
1	Recorded on the seismograph but not felt by humans
2	Felt by some animals
3	Very weakly felt by some humans
4	Can be felt widely in homes and cars
5	Some shaking, breaking of windows, walls may crack, other minor damage
6	Strong tremors, pavements, swimming pools, tennis courts crack, walls begin to fall
7	Major earthquake, buildings and houses collapse, railways and bridges are destroyed
8	Great destruction and loss of life and property in populated areas
9	A catastrophe
10	Total destruction

Tabulating Earthquakes

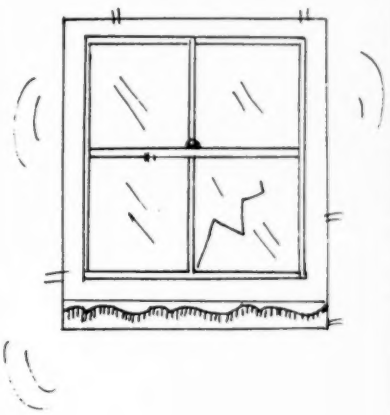
Rate the following situations on the Richter Scale by circling the appropriate numbers.

1 2 3 4 5 6 7 8 9 10

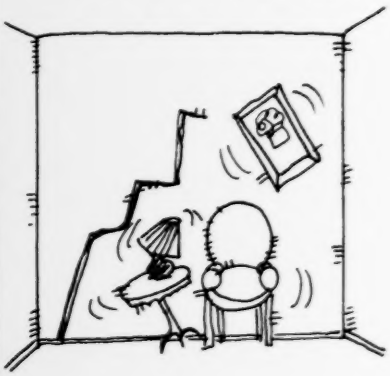


1 2 3 4 5 6 7 8 9 10

1 2 3 4 5 6 7 8 9 10



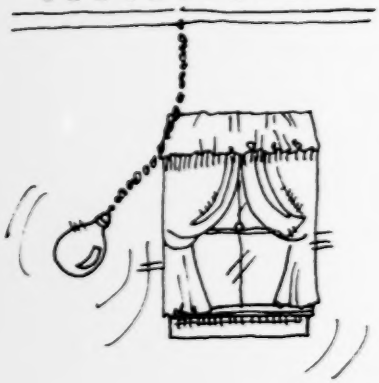
1 2 3 4 5 6 7 8 9 10



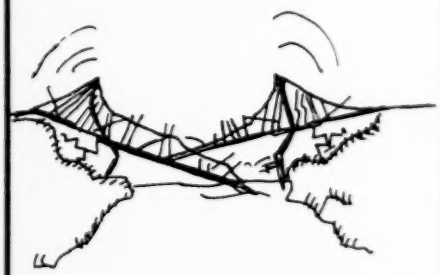
1 2 3 4 5 6 7 8 9 10

1 2 3 4 5 6 7 8 9 10

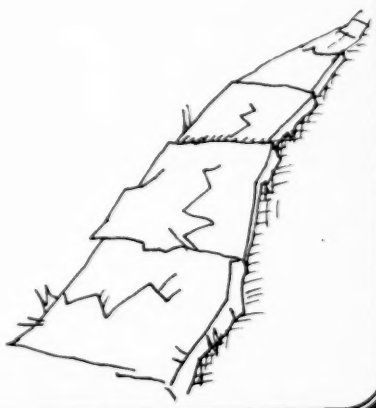
1 2 3 4 5 6 7 8 9 10



1 2 3 4 5 6 7 8 9 10

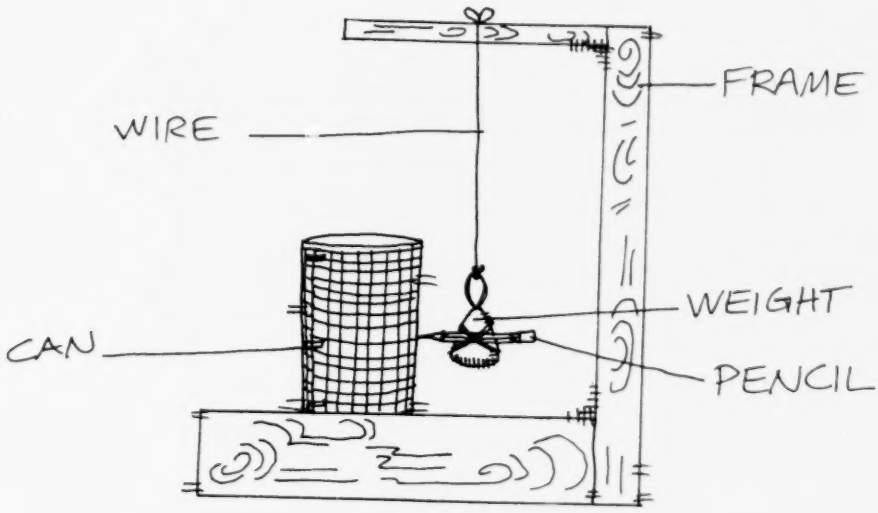


1 2 3 4 5 6 7 8 9 10



The Principle of a Seismograph

Seismographs are delicate instruments which register and record tremors on the earth (earthquakes). They are so delicate that they are able to measure the slightest tremors anywhere on earth. The principle of a seismograph is very simple: a heavy weight at rest tends to remain at rest (enertia). In a seismograph a weight (pendulum) is suspended from a frame which is mounted to the ground on solid rock. During an earthquake the frame will move with the tremors while the pendulum tends to stay still. An attached pen makes a recording of the earthquake on graph paper wrapped around a revolving drum. You can show the principle of a seismograph by making the model below.

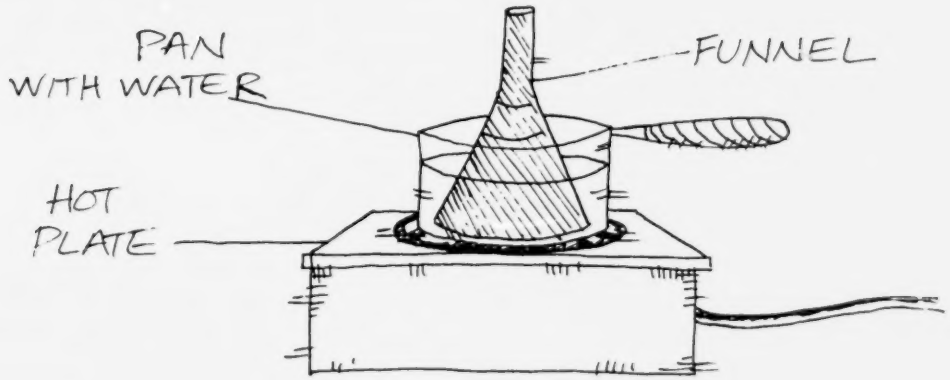


MATERIALS: A frame or support for the weight, a weight, wire, coffee can, graph paper, pencil or pen, tape.

PROCEDURE: Use the wire to suspend the weight; attach the pen to the weight and fasten the graph paper to the drum with tape. Jar the table or desk on which the seismograph rests by dropping books on it or shaking the legs. Describe what happened.

The Action of a Volcano

Volcanoes are formed by the action of red hot molten rock called magma. Magma is not as dense as solid rock, and therefore it tends to rise in the cracks and crevices of the earth's crust. In many cases the magma cools and becomes solid rock before it has a chance to come to the surface. Sometimes, however, it finds a weak spot or crack in the earth's crust and erupts as a substance called lava. This flow of lava is called a volcano.



To show the action of a volcano, do the following activity.

MATERIALS: Heat source such as a hot plate, large metal funnel, small piece of modeling clay, water, pot or pan.

PROCEDURE: Add about one half to two inches of water to the pan and place the funnel in the pan upside down. Cover the open spout of the funnel with a very thin layer of modeling clay. Be certain the clay is loosely covering the spout. Place the pan containing the funnel and water on the hot plate and turn on the heat. Observe what happens. Tell what part of a volcano each of the following represents:

a. water b. funnel c. hot plate d. modeling clay

Make a Hygrometer

The amount of water vapor in the air is called humidity. Most of the moisture comes from the evaporation of oceans, lakes, rivers and streams. Plants and animals also add moisture to the air in the processes of respiration and photosynthesis. The amount of water vapor in the air varies from day to day and depends to a great extent on temperature; warm air can hold more water vapor than cold air. The amount of water vapor the air is holding in comparison to the amount it can hold at that same temperature is called the relative humidity. When the air is holding all the moisture it can possibly hold at that temperature, it is said to be saturated.

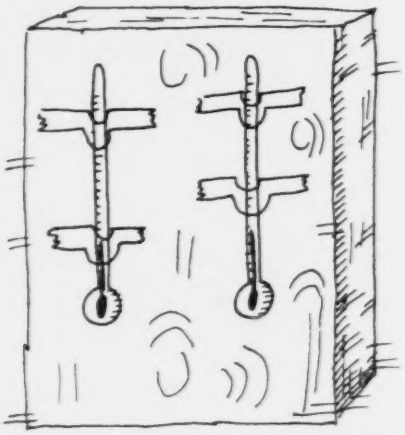
The measurement of relative humidity is an important part of weather reports; it is done by instruments called hygrometers. You can make a simple hygrometer of your own by following the directions below.

MATERIALS: Two centigrade thermometers, cotton shoelace for wick, test tube or small bottle, cardboard or small board for attaching thermometers, rubber band, string or wire, water at room temperature, clear tape.

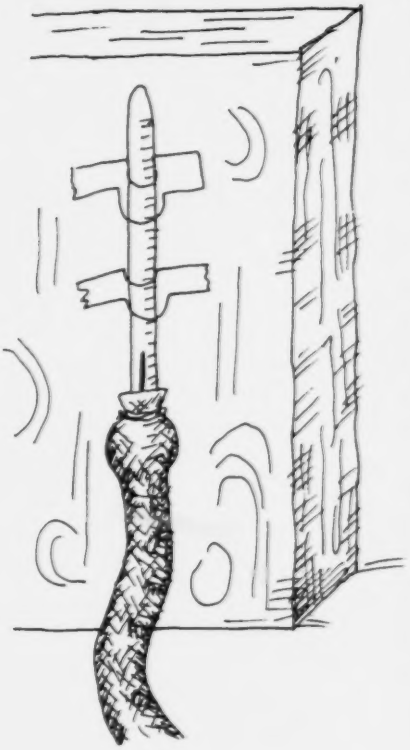
PROCEDURE: With the clear tape or wire, attach the thermometers to the board. To the bottom of the second thermometer, fasten the moistened wick with string, wire or a rubber band. Fill the test tube half full of water. Place the opposite end of the wick into the water in the test tube.

The thermometers will register different temperatures; the wet thermometer will register a lower temperature because the evaporation of the water from the wick has a cooling effect on this thermometer. The drier the air the faster the water will evaporate and the lower the temperature will be on the wet bulb thermometer.

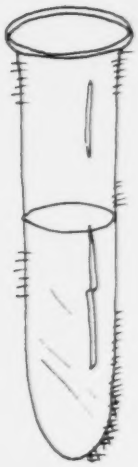
1



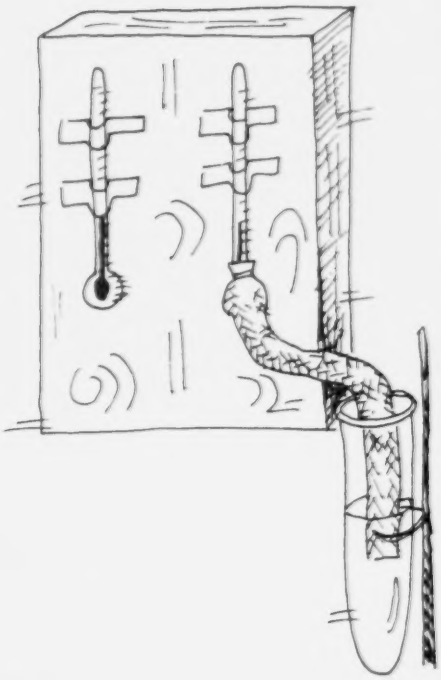
2



3



4



A Table for Finding Relative Humidity

To find the relative humidity, read the temperature on the dry-bulb thermometer. Suppose that it is 20°C. Next read the temperature on the wet-bulb thermometer. Suppose it is 17°C. Subtract the difference between the wet and dry-bulb readings. In this example it is 3°C. Now find the dry-bulb reading (20°C) on the left-hand side of the scale. From the top of the scale find the difference in degrees (3°C). With your finger follow the numbers across the row from 20°C until your finger is under the column which reads 3°C. The number will be 74. This tells you that the relative humidity is 74% when the dry-bulb thermometer is 20°C and the wet-bulb thermometer is 17°C.

SCALE TO DETERMINE THE RELATIVE HUMIDITY

DIFFERENCE BETWEEN DRY-BULB AND WET-BULB TEMPERATURES (°C)

DRY-BULB TEMPERATURE (°C)	1	2	3	4	5	6	7	8	9	10
0	81	64	46	29	13					
2	84	68	52	37	22	7				
4	85	71	57	43	29	16				
6	86	73	60	48	35	24	11			
8	87	75	63	51	40	29	19	8		
10	88	77	66	55	44	34	24	15	6	
12	89	78	68	58	48	39	29	21	12	
14	90	79	70	60	51	42	34	26	18	10
16	90	81	71	63	54	46	38	30	23	15
18	91	82	73	65	57	49	41	34	27	20
20	91	83	74	66	59	51	44	37	31	24
22	92	83	76	68	61	54	47	40	34	28
24	92	84	77	69	62	56	49	43	37	31
26	92	85	78	71	64	58	51	46	40	34
28	93	85	78	72	65	59	53	48	42	37
30	93	86	79	73	67	61	55	50	44	39
32	93	86	80	74	68	62	57	51	46	41
34	93	87	81	75	69	63	58	53	48	43
36	94	87	81	75	70	64	59	54	50	45

RELATIVE HUMIDITY (%)

A Colorful Hygrometer

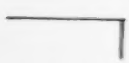
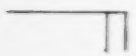
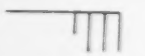
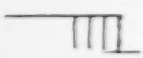
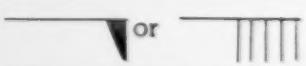
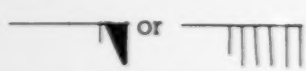
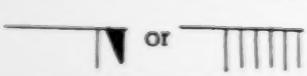
Students will enjoy making a different kind of hygrometer, one which changes in color as the amount of moisture in the air varies. To make this chemical hygrometer, you will need the materials listed below.

MATERIALS: White construction paper, 2 teaspoons of cobalt chloride, 1 teaspoon of salt, ½ teaspoon of calcium chloride, enough water to mix and make a medium-thick solution (2 to 3 teaspoons).

PROCEDURE: Dissolve all the ingredients in order, one at a time. The solution will be red. Out of construction paper, cut out the shape of an umbrella or other suitable shape and dip it into the solution until it is saturated. Remove the umbrella and tape it to the outside of a window or some other suitable place where it will be out-of-doors and also protected from direct exposure to rain. Your hygrometer will turn blue when the humidity is low and pink when the humidity is very high or when it is raining. The change in color is due to the cobalt chloride; the salt and calcium absorb the moisture from the air.

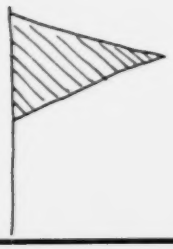
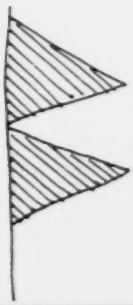
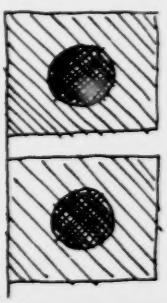
The Beaufort Scale for Wind Speed

Air in motion is called wind. Measuring the speed and direction of wind is important in weather forecasting. The symbol for wind on a weather map is a straight horizontal line with smaller lines at right angles near the end. The smaller lines are called feathers. The number of feathers indicates the speed of the wind. The end of the symbol opposite the feathers points in the direction the wind is heading.

BEAUFORT SCALE (BO-FERT) NUMBER	SYMBOL	SPEED IN MILES PER HOUR	TERM	EFFECT
0	None	Less than 1 mph	Calm	Smoke goes straight up
1		1 to 3 mph	Light air	Smoke bends
2		4 to 7 mph	Very slight breeze	Smoke begins to drift with wind. Leaves move faintly
3		8 to 12 mph	Slight breeze	Leaves rustle
4		13 to 18 mph	Gentle breeze	Leaves moving, clothes on line blowing
5		19 to 24 mph	Moderately strong breeze	Small trees and branches bend
6		25 to 31 mph	Strong breeze	Larger branches and trees bend
7		32 to 38 mph	Near gale	Walking becomes difficult. Umbrellas are useless
8		39 to 46 mph	Gale force.	Limbs break off trees
9		47 to 54 mph	Strong gale	Damage to houses and roofs
10		55 to 63 mph	Storm	Trees uprooted. Severe damage to homes and roofs
11		64 to 75 mph	Severe storm	Heavy damage to trees and property
12		75 mph and above	Hurricane force	Extreme damage

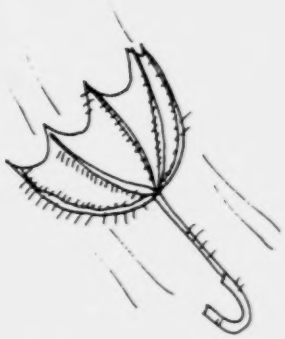
Seacoast Warnings

The United States weather stations along the seacoasts display warning signals which tell viewers of impending storms and weather conditions. During the day flags are used; at night the signals are given in lights. Below are the warning signals; color them as indicated in the key. Give their approximate ratings on the Beaufort Scale (page 24).

DAYTIME SIGNAL	NIGHTIME SIGNAL	WARNING
		Small craft warning, near gale Beaufort Scale ____
		Gale winds Beaufort Scale ____
		Whole gale force winds Beaufort Scale ____
		Hurricane force Beaufort Scale ____ Key: IS RED IS BLACK

Tabulating the Wind

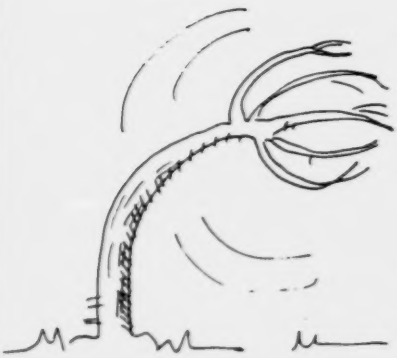
What ratings do the following drawings have on the Beaufort Scale?



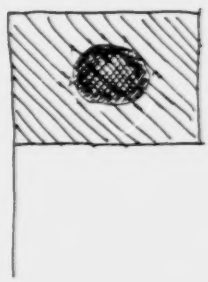
Beaufort Scale ____

Beaufort Scale ____

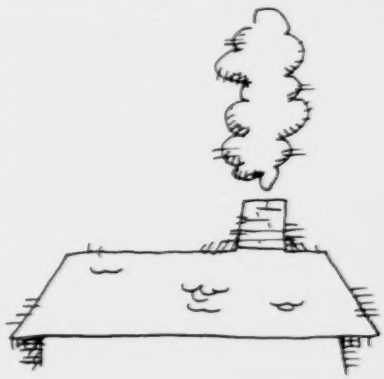
Beaufort Scale ____



Beaufort Scale ____

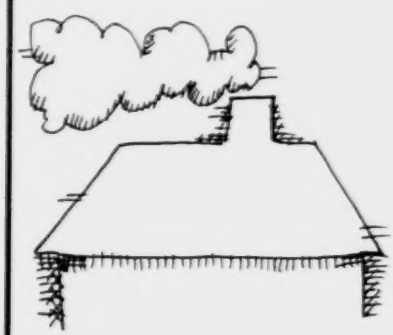


Beaufort Scale ____

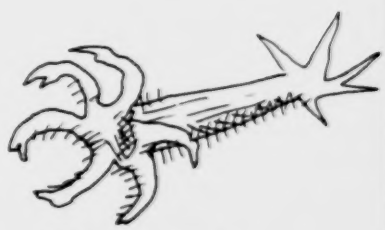


Beaufort Scale ____

Beaufort Scale ____

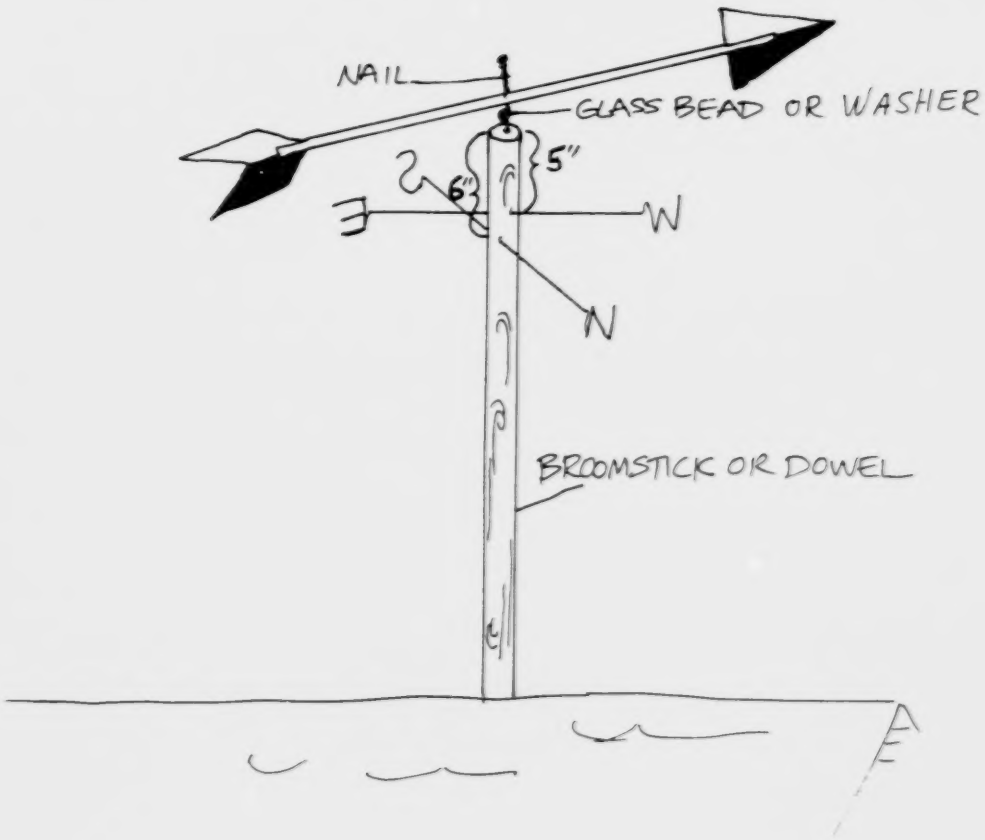


Beaufort Scale ____



Beaufort Scale ____

A Wind Vane



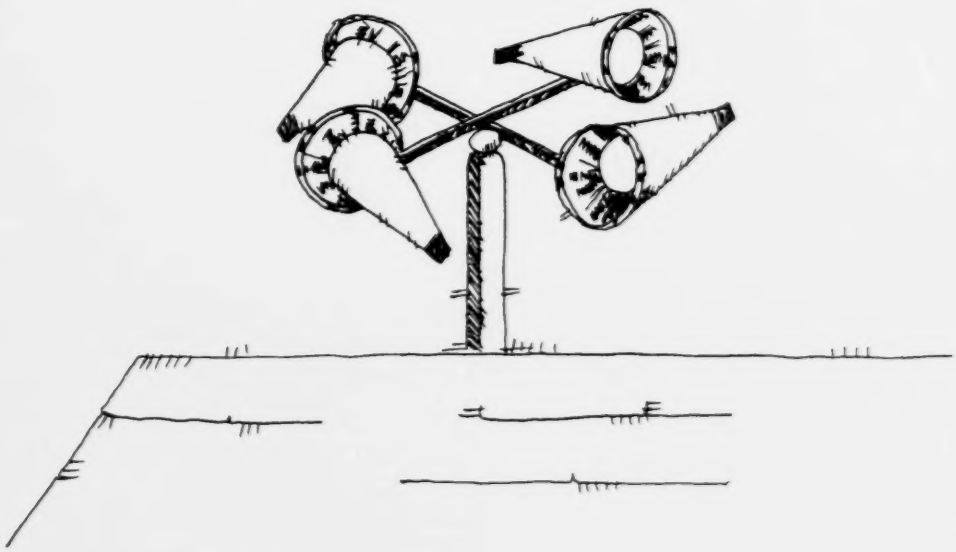
A wind vane is an interesting and valuable instrument which will help you determine the direction of the wind. An ideal spot for a wind vane is in a high open space, such as the roof of a garage or tool shed. To make a wind vane, gather the materials listed below and follow the directions.

MATERIALS: A dowel for the arrow, a thin sheet of metal such as aluminum, metal shears, two coat hangers, drill, nail or wood screw, washer or glass bead, broomstick or dowel for base, knife or saw for cutting.

PROCEDURE: Drill two holes through the base about five and six inches from the top; insert a coat hanger through each hole. Fashion the letters N and S on one coat hanger and E and W on the other. Cut the aluminum arrow parts with the metal shears. With a knife or saw carefully make a groove in each end of the dowel; insert the arrow parts into the grooves. Balance the arrow on a knife point to find the balance point; drill a hole here for the screw or nail. Place the washer between the broomstick and arrow. Attach to base. Be sure the arrow can rotate freely. Use a compass to position the letters correctly.

A Simple Anemometer

An anemometer is an instrument which measures the speed of the wind. A simple anemometer can be made from small pie tins, aluminum spoons, or funnels with closed spouts which catch the wind and turn freely when the wind blows. The faster the wind blows, the more quickly the anemometer will revolve. The anemometers used in weather stations are very accurate and have meters attached to them to record the wind speed. To make an anemometer for your class, follow the directions below.



MATERIALS: Four metal cups, funnels*, or small pie tins, a broomstick base, two sticks, a nail, a washer.

PROCEDURE: Attach the cups or funnels to the sticks; be certain they all face the same direction. Use the nail and washer to mount the cups to the broomstick. Be sure the cups can move freely. Mount the anemometer in an open area on top of a garage or shed. The speed with which the cups revolve will give an indication of the speed (velocity) of the wind.

*If funnels are used, be certain to close the open ends so that no air passes through.

Temperature

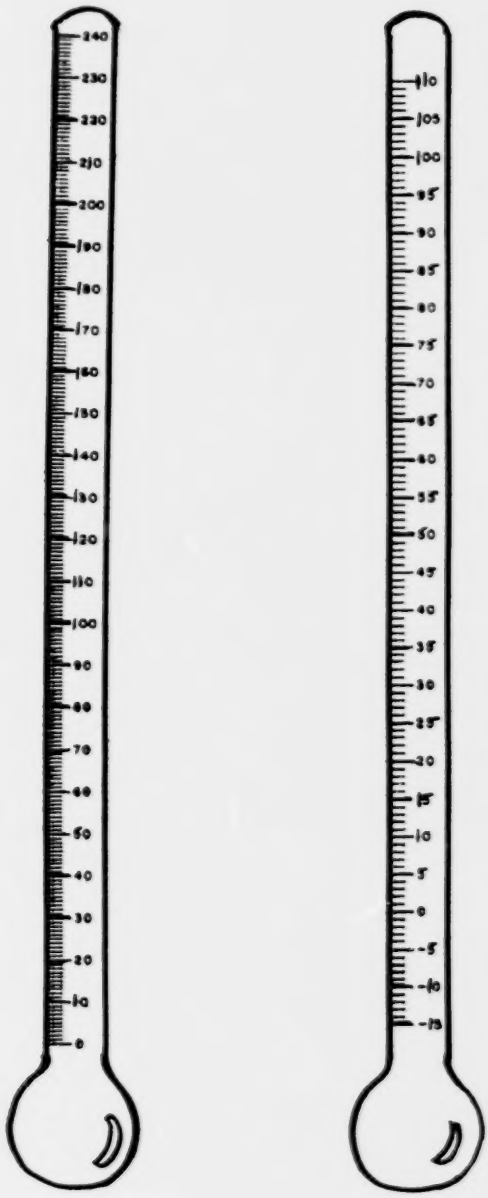
The degree of hotness or coldness is called temperature. The instrument for measuring temperature is a thermometer. The modern day thermometer was invented by Fahrenheit in 1709; Fahrenheit first used alcohol and later mercury in his invention. On the Fahrenheit thermometer, water freezes at 32° and boils at 212°. In 1743 Celsius devised the centigrade thermometer which has a freezing point of 0° and a boiling point of 100°.

You are probably well-acquainted with thermometers and in your home may have several; one type of thermometer is used to detect the presence of an elevation or rise in the body temperature. The normal body temperature is close to 98.6 degrees. A significant rise of two degrees or more is a good indication that there is an infection in some part of the body, and the patient must take precautions. Another type of thermometer is used to tell the temperature of our surroundings. Comfortable room temperatures are around seventy degrees.

Thermometers are made from glass tubing which has a narrow bore and an enlargement or bulb at the bottom. A liquid metal, mercury, or an artificially colored liquid such as alcohol is added in exact amounts before the thermometer is sealed. Mercury and alcohol are the preferred substances for use in thermometers because they expand uniformly as they are heated, and their freezing points are very low.

Measuring Temperature

Compare the centigrade or Celsius thermometer and the Fahrenheit thermometer below. Notice that a degree on the Fahrenheit thermometer is smaller than a degree on a Celsius thermometer. The size of a degree on a Fahrenheit thermometer is 5/9 of a Celsius degree.



Fahrenheit Celsius

Water freezes at 32° Fahrenheit and boils at 212°. Use a ruler to find the corresponding temperatures on the Celsius thermometer.

Changing Degrees

To change Fahrenheit degrees to Celsius degrees, do the following steps in order:

a. First subtract 32
b. Then multiply by 5
c. Finally divide by 9

To change Celsius degrees to Fahrenheit degrees do these steps in order:

a. First multiply by 9
b. Next divide by 5
c. Add 32

You can do the same problems by using the following algebraic formulas:

$C^\circ = 5/9\ (F^\circ - 32)$
$F^\circ = (9/5 \times C^\circ) + 32$

Use either (or both) of these methods to do the problems below.

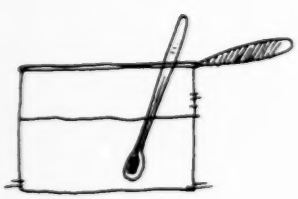
1. Mark is sick. His mother takes his temperature on a Fahrenheit thermometer; it is 101° Fahrenheit. What would it be on a Celsius thermometer?

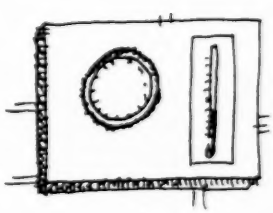
2. A certain liquid boils at 95° Celsius. What would the boiling point of the liquid be on a Fahrenheit thermometer?

3. On a fall morning the 8 o'clock temperature in Scranton, Pa., was 7° Celsius. What is that on the Fahrenheit scale?

4. John came home from school and checked the thermostat in his house. It registered 68° Fahrenheit. What is that in Celsius degrees?

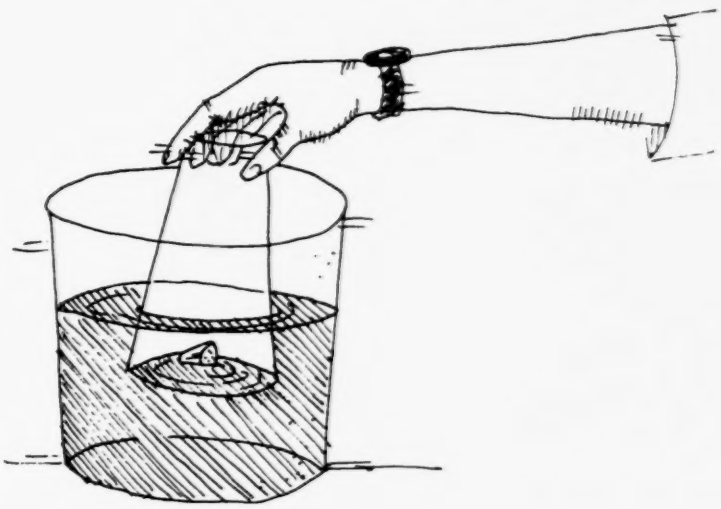
5. Can you identify the four types of thermometers pictured below?





Air Pressure

We live on the bottom of an ocean of air, but it is sometimes difficult for us to understand that air has weight and exerts pressure as a result of its weight. On each square inch of your body there are 14.7 pounds of pressure. On the entire surface of a human body there is a total air pressure which varies from 10 to 20 tons! Just as oceanic animals are not crushed by the weight of the water above them, we are not crushed by the weight of air because the inner pressure of our bodies pushing outwards equalizes the air pressure pushing down upon us. To show how air occupies space and exerts pressure, do the following experiment:



MATERIALS: Large beaker or bell jar, small beaker, cork, water.

PROCEDURE: Fill the bell jar half full with water. Place a cork in the center of the bell jar. Lower the smaller beaker mouth downward over the cork into the water. Press into the water.

QUESTION: Why did the smaller beaker not fill with water although it was pushed below the water level in the bell jar?

Does Air Have Weight?

To show that air has weight and can exert pressure, do the following experiment:

MATERIALS: A large, *clean* metal can with a screw cap, hot plate, ½ cup of water, pitcher of cold water, cookie sheet, potholder.

PROCEDURE: Into the clean can pour about ½ cup of water. Place the can on the hot plate and heat the water until a cloud of steam comes out the opening. Quickly cap the can and remove from the hot plate to the cookie sheet. Pour a pitcher of cold water over the can. Answer the following questions:

1. What did the steam force out of the can?

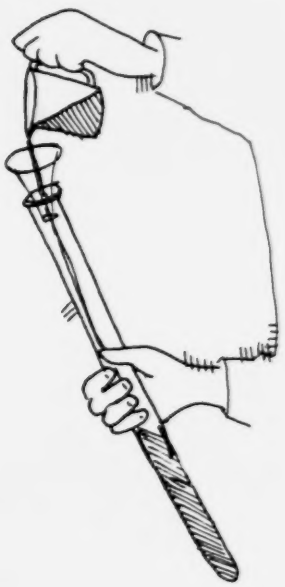
2. The cold water which was poured over the can caused the remaining steam to quickly change back to what substance?

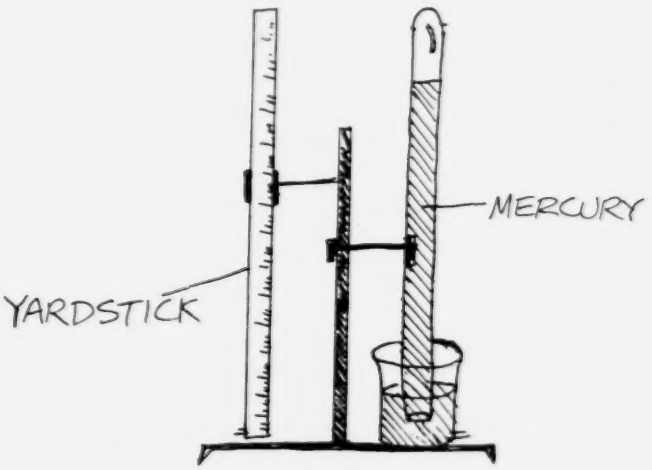
3. When the steam in the can changed back to water, what was left in its place?

4. What invisible force collapsed the can?

Make a Mercury Barometer

A barometer is an instrument used to measure air pressure. It was invented in 1643 by the Italian scientist, Torricelli. Torricelli showed that air pressure was due to the weight of air and that it varied from place to place. To make a simple mercury barometer similar to the type that Torricelli made, follow the directions below.

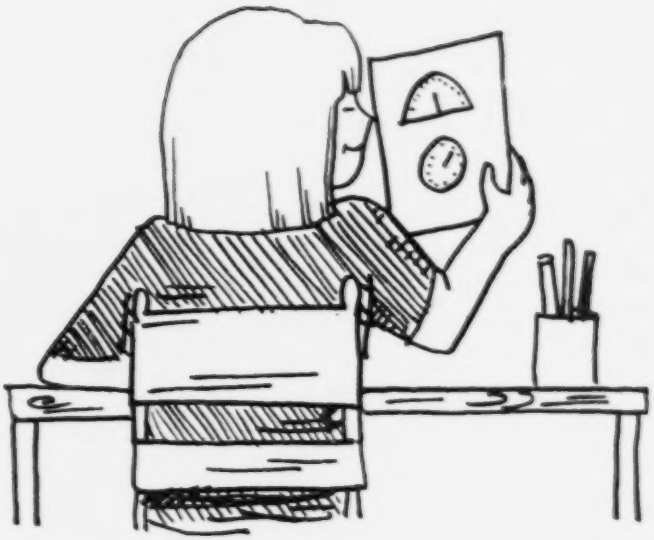




MATERIALS: A ring stand, two clamps, a long glass tube (90 cm or 36 inches) closed at one end, a yardstick, a beaker, mercury to fill the tube and some for the beaker, a funnel.

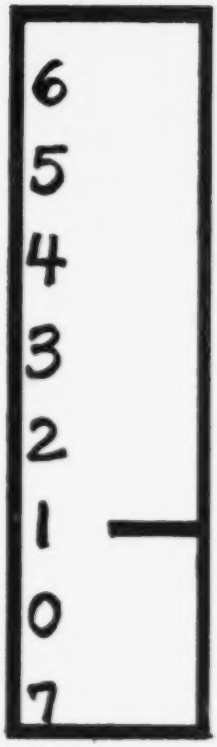
PROCEDURE: Using the beaker and a funnel, fill the glass tubing with mercury; leave remaining mercury in the beaker. Press your finger over the open end of the tube and invert it into the beaker containing the remaining mercury. (Some of the mercury will drop into the beaker.) Carefully secure tubing to the ring stand with clamps. With the second clamp secure the yardstick. The mercury that falls into the beaker leaves a partial vacuum at the top of the tube. The air pressure on the mercury in the beaker will cause the mercury in the tube to rise and fall as the pressure of the air varies from day to day. Use the yardstick or meterstick to take your readings.

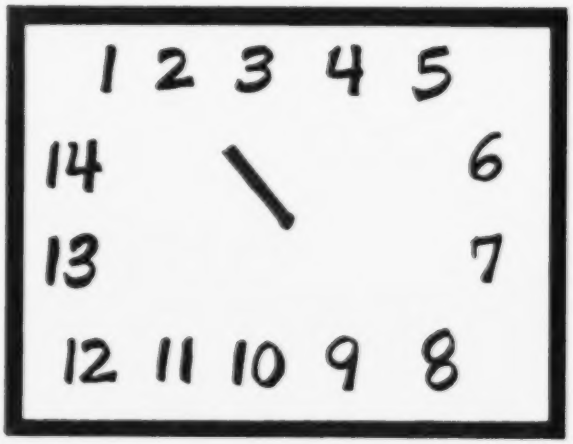
Making Tables for Accurate Readings



Thermometers, scales, clocks and various instruments come in a variety of shapes and sizes. Some are easy to read; others are not. All instruments should be designed to read easily and accurately. To make a simple classroom study of easy-to-read instrument shapes, cut out each of the instrument dials separately and attach to cardboard, if you wish, for easy handling. Use an opaque projector* which has been previously checked to give a sharp focus. With the projector off, position the dial to be read. Flick the projector on and off quickly. Have students record their readings on a piece of paper. Project the rest of the dials in the same manner. Compare readings to determine which dial shape was most often read correctly, the second most accurate, etc. Have students make instrument dials of their own to test for accuracy in reading, using various dial shapes and number designs. Keep the same number size for all dials being compared.

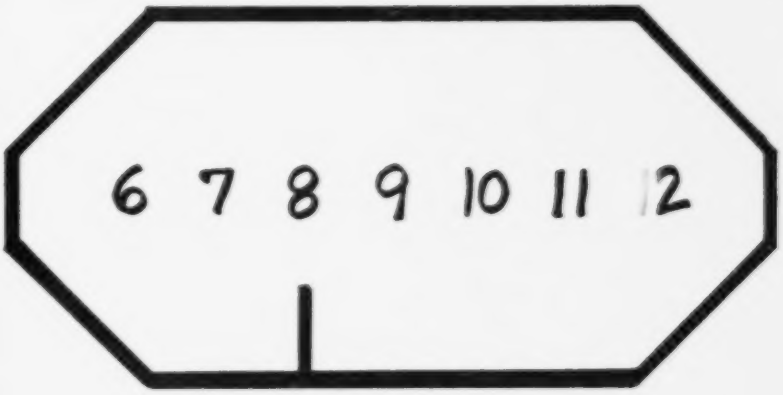
*Transparencies can also be made of the dials to be used with an overhead projector if one is available. Use in the same manner as directed above.

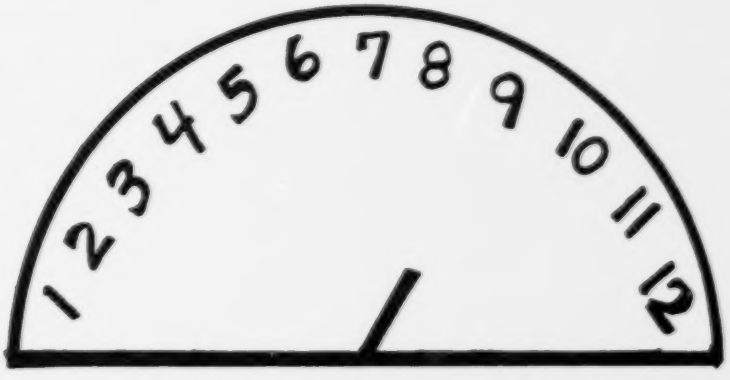

6
5
4
3
2
1
0
7


1 2 3 4 5
14
6
13
7
12 11 10 9 8

4 3 2 1
5 18
6 17
7 16
8 15
9 14
10 13
11 12

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


6 7 8 9 10 11 12


1 2 3 4 5 6 7 8 9 10 11 12

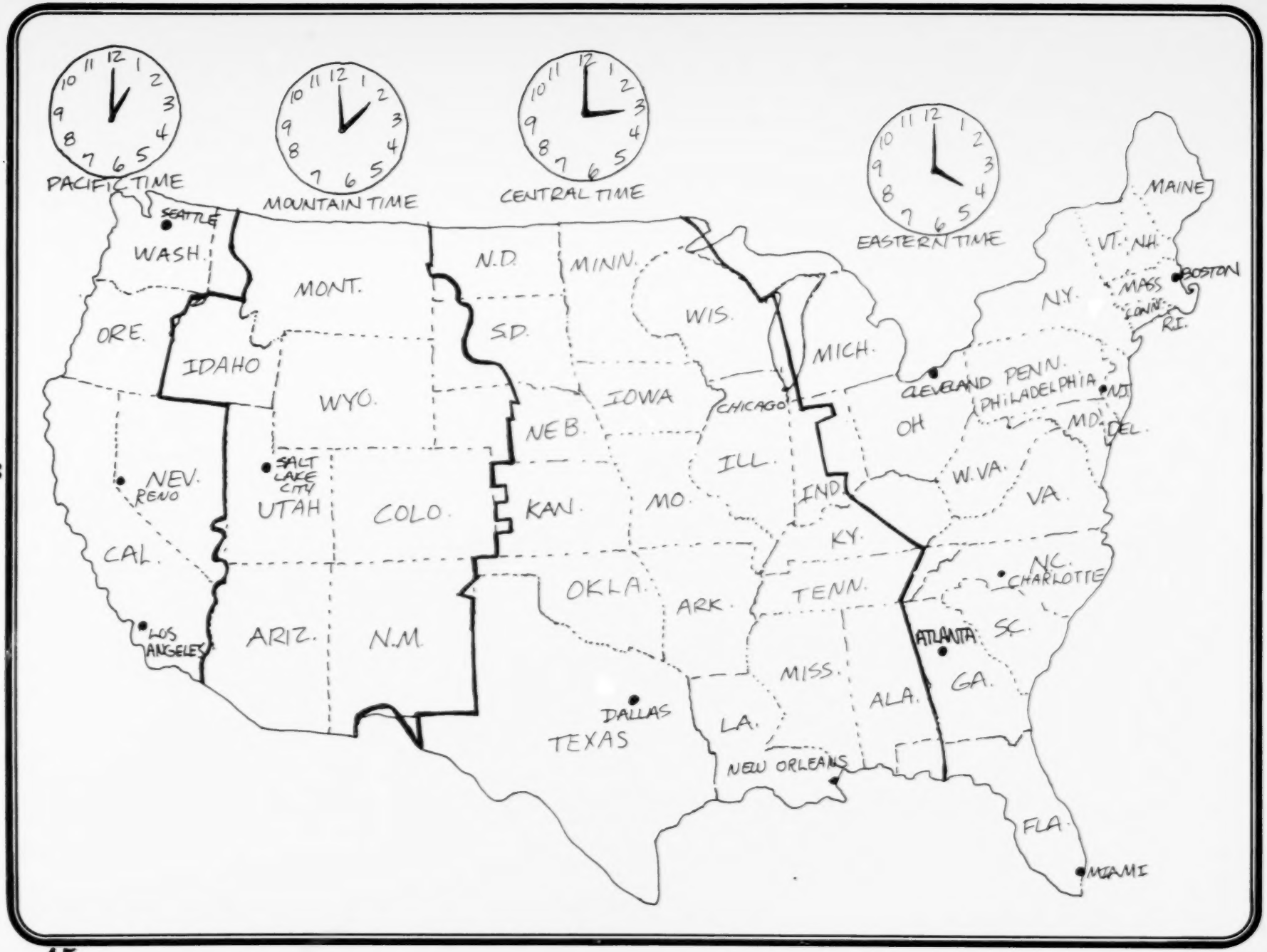
Tabulating Time in the United States

The four time zones of the United States from east to west are: Eastern Standard Time, Central Standard Time, Mountain Standard Time, and Pacific Standard Time. Moving from east to west each time zone is one hour earlier. When it is 9:00 a.m. in New York City, it is 8:00 a.m. in Chicago, 7:00 a.m. in Denver and 6:00 a.m. in San Francisco.

Daylight-saving time means that the people in many states push their clocks ahead one hour in the spring on a chosen date to take advantage of an extra hour of daylight in the evening rather than in the early morning. The clocks are set back again in the fall to regular standard time.

Use the Time Zone Map on the next page to find the time in the cities below when another city's time is given. Use standard time in all cases.

WHEN IT'S	IT'S
12:00 Midnight in Boston	_____ in Los Angeles
5:00 p.m. in Dallas	_____ in Chicago
3:04 a.m. in Salt Lake City	_____ in New Orleans
1:00 p.m. in Reno	_____ in Atlanta
6:15 a.m. in Seattle	_____ in Philadelphia
2:30 p.m. in Miami	_____ in Charlotte
2:00 a.m. in Cleveland	_____ in Chicago


PACIFIC TIME
MOUNTAIN TIME
CENTRAL TIME
EASTERN TIME
SEATTLE
WASH.
ORE.
CAL.
NEV.
RENO
LOS ANGELES
MONT.
IDAHO
WYO.
SALT LAKE CITY
UTAH
COLO.
ARIZ.
N.M.
N.D.
S.D.
NEB.
KAN.
OKLA.
TEXAS
DALLAS
MINN.
IOWA
MO.
ARK.
LA.
NEW ORLEANS
WIS.
ILL.
CHICAGO
MICH.
IND.
KY.
TENN.
MISS.
ALA.
OH
W.VA.
VA.
NC.
CHARLOTTE
SC.
GA.
ATLANTA
FLA.
MIAMI
N.Y.
PENN.
CLEVELAND
PHILADELPHIA
MD.
DEL.
NJ.
MAINE
VT.
N.H.
MASS
CONN.
R.I.
BOSTON

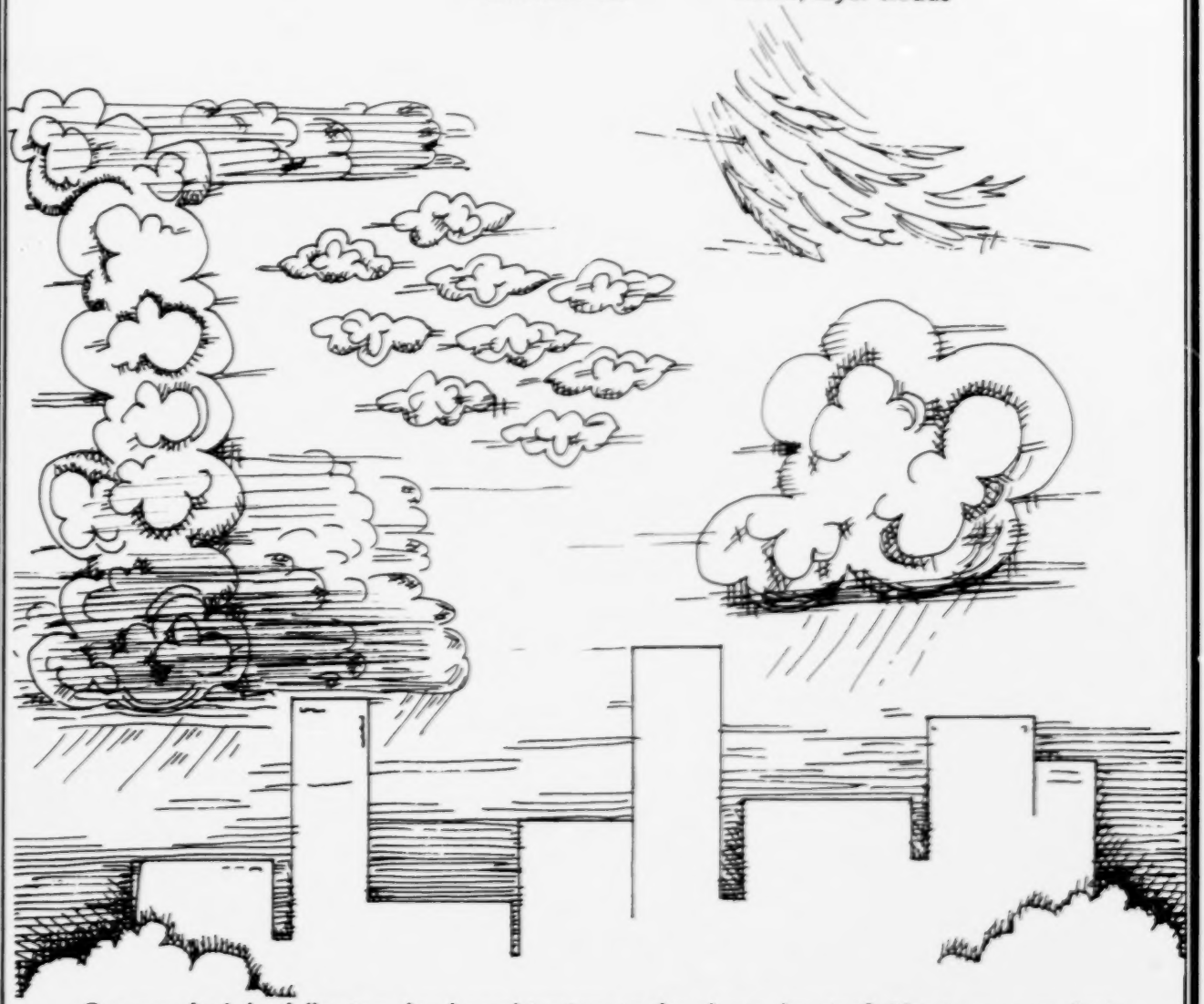
How Clouds Are Named

Clouds have been given Latin names which aptly describe them. Here are some cloud names and their Latin meanings:

Cirrus	-	curl
Nimbus	-	storm
Alto	-	high
Cumulo	-	pile or mass
Stratus	-	layer

By combining the Latin names, the descriptions of the clouds are doubled:

Altocirrus	-	high, curly clouds
Cumulonimbus	-	mass, storm clouds
Nimbostratus	-	storm, layer clouds



Can you find the following cloud combinations in the above drawing? Altocirrus, cumulonimbus, nimbostratus, altostratus, altocumulus.

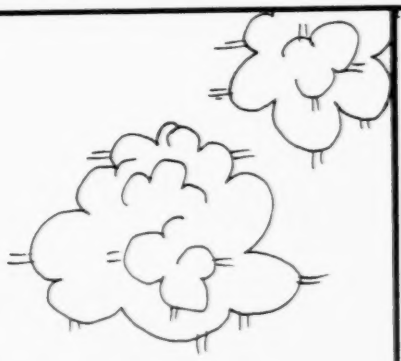
Types of Clouds and Their Symbols

Draw the cloud in the space beside the name and description on the left. Learn the weather symbols for the clouds which are given on the right.

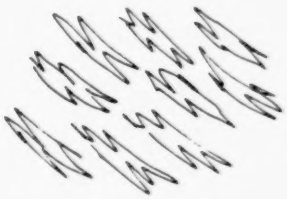
CLOUD	SYMBOL
CIRRUS high wispy clouds	
CUMULUS low to high puffy clouds	
STRATUS low, flat layers of clouds	
CIRROSTRATUS wispy layers, a thin veil	
ALTOSTRATUS high layer of clouds	
CUMULONIMBUS thunderstorm clouds	
NIMBOSTRATUS dark layers of clouds	

Tabulating the Clouds

Can you identify the cloud formations below? Choose your answers from the following list: stratocumulus, altocumulus, cirrus, altostratus, cumulus, cirrocumulus, cumulonimbus, cirrostratus, and stratus.



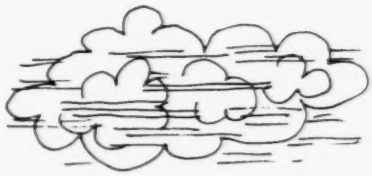
Cloud formation



Cloud formation

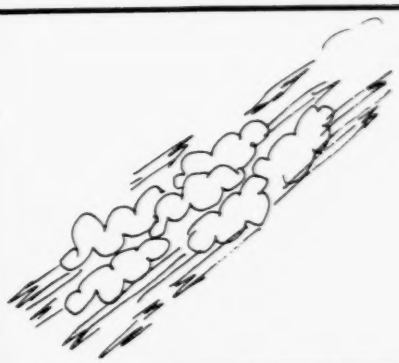
Cloud formation

Cloud formation

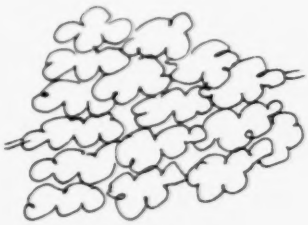


Cloud formation

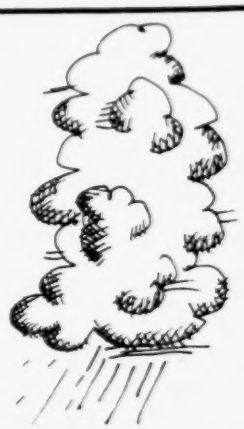
Cloud formation



Cloud formation



Cloud formation



Cloud formation

Sky Symbols

The symbols used to show how much of the sky is covered by clouds are very easy to understand. See if you can correctly match the symbols on the left to their descriptions on the right.

SYMBOL	DESCRIPTION
a	Sky is completely covered by clouds. Symbol _____
b	About ½ of the sky is covered by clouds. Symbol _____
c	Sky is covered by smoke or fog. Symbol _____
d	The sky is clear. Symbol _____
e	About ¼ of the sky is covered by clouds. Symbol _____

Make a Rain Gauge

One of the simplest of all weather instruments to make is a rain gauge. To make one follow the instructions below.

MATERIALS: A large waterproof can close to 8 inches in diameter, a plastic ruler.

PROCEDURE: Set the rain gauge can in an open area. To measure the rainfall, dip the plastic ruler straight into the water. Note the mark at the top of the level. To measure snow, first melt it, then measure it as you do for rain. Generally about ten inches of snow equals about one inch of water.

Mapping the Weather

Over 600 weather stations throughout the United States collect weather information several times a day. This information gives the air pressure, temperature, relative humidity, wind direction, wind speed and sky conditions at these stations. Such things as rain, sleet, snow, etc., are also reported. This information is sent by code to a main station and put on a weather map. Weather satellites revolving around the earth take pictures of the sky conditions and transmit them to the stations. Radar waves which are reflected from water droplets, ice crystals in the clouds and falling rain form pictures on a radarscope. Scientists, called meteorologists, study this information and from it predict future weather conditions. The information is now ready to be sent to newspapers and radio and television stations. The symbols used on weather maps to indicate weather conditions over large areas are shown below.

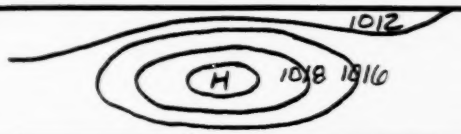
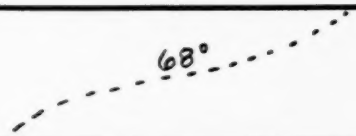
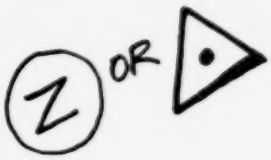
	Cold front: a large moving mass of cold air which changes weather quickly
	Warm front: a large moving mass of warm air which changes weather slowly.
	Stationary front: a large mass of warm and cold air which is not moving.
	Isobars: solid lines on a weather map joining places of equal air pressure.
	Isotherms: broken lines on a weather map joining places of equal temperature.

Table of Weather Symbols

The symbols below are used by weathermen to indicate a variety of weather conditions.

F or	Fog
	Squalls
	Drizzle
Z or	Sleet
R ,	Rain, Cloudy
	Haze
	Hail
S or	Snow
T or	Thunder

Match the Word to the Weather Symbol

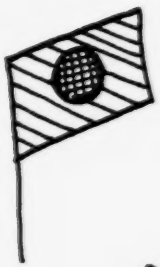


Isotherm

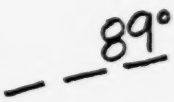
Fog

Cirrus cloud

Warm front



Thunderstorms

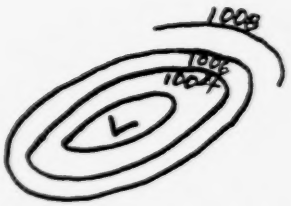


Gale force winds

Cold front

55 to 65 mph winds

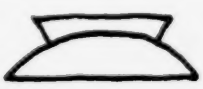
Cumulo-nimbus or storm clouds



Isobars indicating low pressure

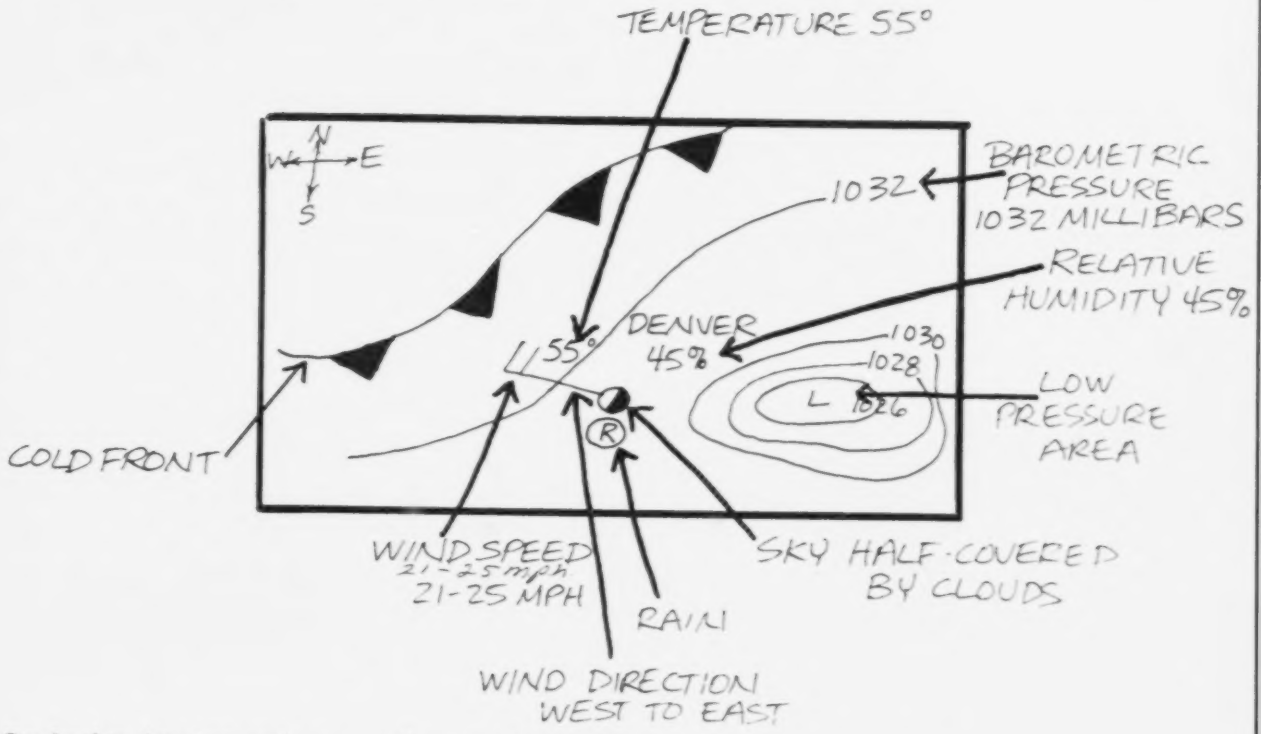
8 to 12 mph winds and a clear sky

Sleet

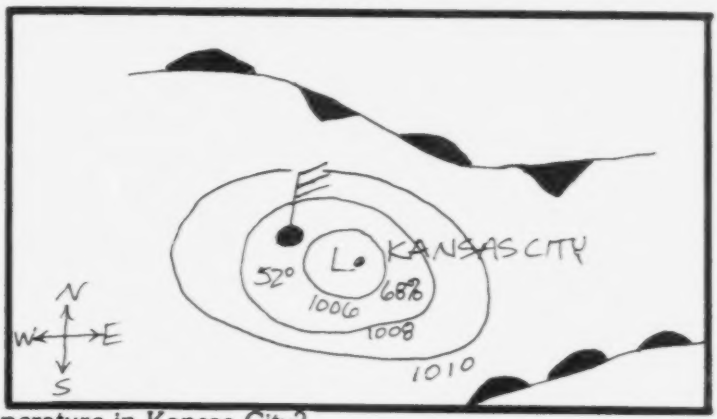


Reading a Weather Map

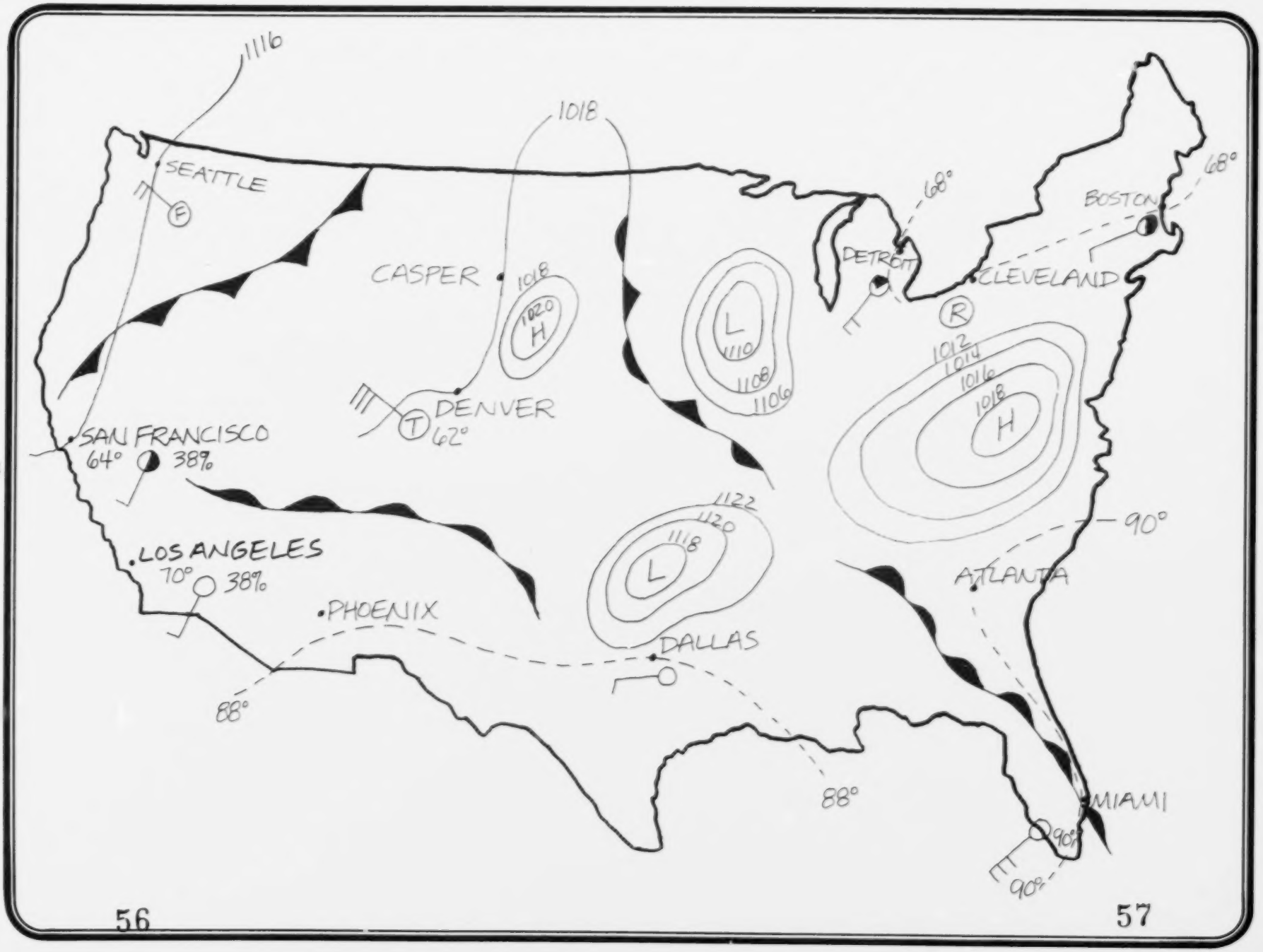
A portion of a weather map is explained below. Use it to help you answer the questions concerning the weather in Kansas City on the bottom half of this page.



Study this drawing and answer the questions below.



1. What is the temperature in Kansas City?
2. In which direction is the wind blowing?
3. What is the speed of the wind?
4. Is the air pressure in Kansas City lower than in the surrounding areas? What is the air pressure in Kansas City?
5. What kind of front is north of Kansas City?
6. What kind of front is south of Kansas City?
7. What is the relative humidity in Kansas City?


1116
1018
SEATTLE
F
CASPER
1018
1020
H
DENVER
T
62°
SAN FRANCISCO
64°
38%
LOS ANGELES
70°
38%
PHOENIX
88°
L
1110
1108
1106
1122
1120
1118
L
DALLAS
88°
68°
DETROIT
R
BOSTON
68°
CLEVELAND
1012
1014
1016
1018
H
90°
ATLANTA
MIAMI
90°
90°

56

57

Questions on a Weather Map

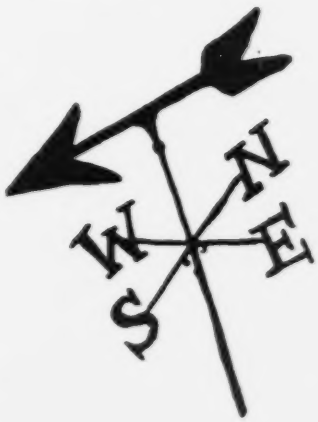
Study the weather map on page 49; use it to answer the following questions:

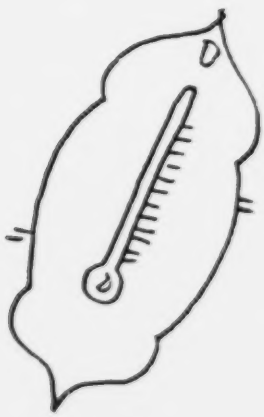
1. Above what city is a low pressure area indicated?
2. What kind of front is southwest of Atlanta, Georgia?
3. The temperature in Miami is the same as what other city?
4. What is cloud coverage in San Francisco?
5. What two northeast cities have the same temperature?
6. What is the broken line indicating the same temperature called?
7. What are solid lines indicating the same barometric pressure called?
8. What is the condition of the sky over Seattle?
9. What is the speed of the wind in Seattle?
10. Are the skies cloudy in Dallas?
11. What city has 25% of its sky covered with clouds?
12. Which two cities have wind speed of 25 to 31 mph?
13. What kind of front is in the north central part of the United States?
14. What is the relative humidity in Los Angeles?
15. Above which city is the highest barometric pressure?
16. Which two cities have a barometric pressure of 1116?
17. To the south of which city is it raining?
18. What is the temperature in San Francisco?
19. What kind of front is south of Seattle?
20. In which city is there thunder?

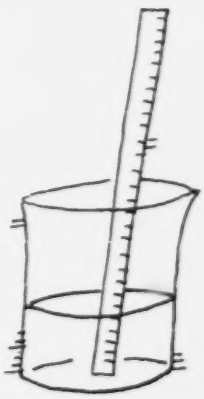
58

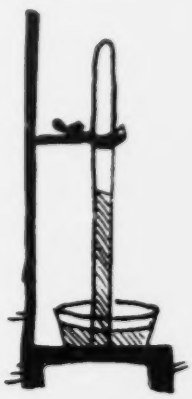
Make a Classroom Weather Station

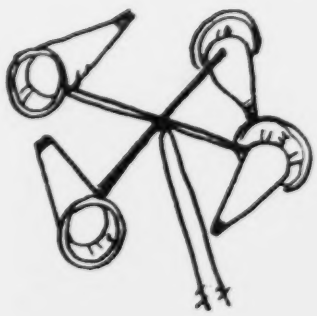
As a special project, collect the weather instruments made in your class and assemble them into a classroom weather station. Take daily readings of temperature, air pressure, rainfall, wind direction, and relative humidity. Check with the weather reports in your local paper and compare your data for accuracy. Record your data on the following page.





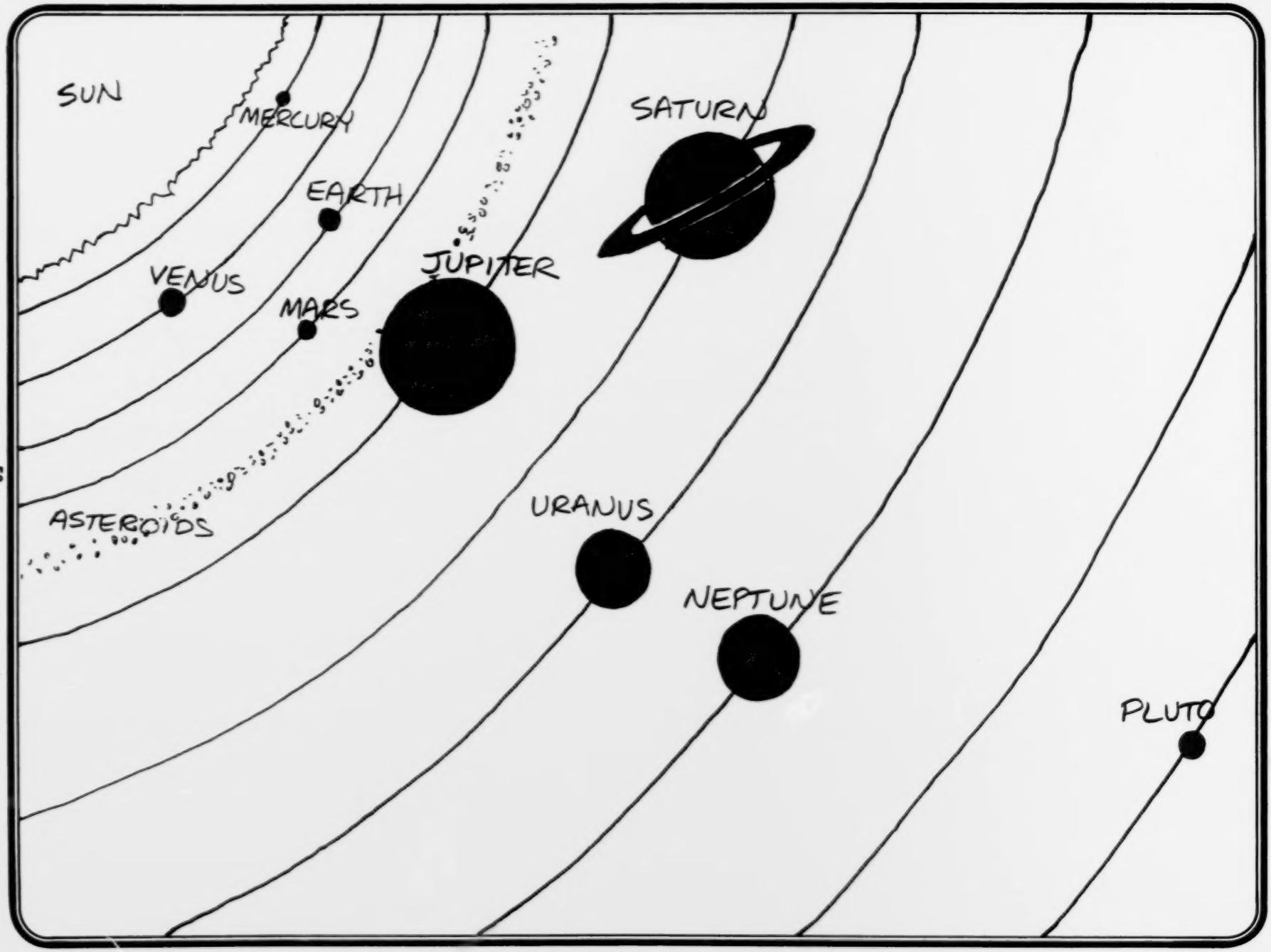






Weather Tabulations

DATE	TEMPERATURE	AIR PRESSURE	RAINFALL	WIND DIRECTION	RELATIVE HUMIDITY


SUN
MERCURY
EARTH
VENUS
MARS
JUPITER
SATURN
ASTEROIDS
URANUS
NEPTUNE
PLUTO

53

61

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Make a Solar Model to Scale

A solar model system made to scale will give students an idea of the comparative sizes and distances of the planets from the sun. Use a ruler to mark off the diameters of the planets; use a compass to draw the circles. Attach the planets to the bulletin board or wall. Planets can be identified with tags until the students learn them in order of their distances from the sun.

PLANET	SCALE DIAMETER	DISTANCE FROM THE SUN
MERCURY	½ inch	2 inches
VENUS	1¼ inches	4 inches
EARTH	1¼ inches	6 inches
MARS	¾ inch	8 inches
JUPITER	14½ inches	2 feet 2 inches
SATURN	12 inches	4 feet 2 inches
URANUS	4¾ inches	8 feet 2 inches
NEPTUNE	4½ inches	13 feet
PLUTO	¾ inch	17 feet

Tabulating Solar System Facts

Planet	Approximate Distance from Sun in Millions of Miles	Length of Year (time to orbit around the sun)	Approximate Time for Rotation	Number of Satellites	Approximate Diameter in Miles
Mercury	36	88 days	59 days	0	3,100
Venus	67	225 days	243 days	0	7,700
Earth	93	365 days	24 hours	1	7,926
Mars	141.5	687 days	24½ hours	2	4,200
Jupiter	483	11.9 years	10 hours	13	88,700
Saturn	886	29.5 years	10½ hours	10	75,100
Uranus	1,783	84 years	11 hours	5	29,600
Neptune	2,793	165 years	16 hours	2	27,700
Pluto	3,666	248 years	6 days 9 hours	0	3,600

Use the above table to answer the following questions:

1. Which planet has the most moons or satellites? _____
2. Which planet takes the longest time to rotate on its axis? _____
3. Which planet takes the longest time to rotate around the sun? _____
4. Which is the smallest planet? _____
5. Which planets have no moons? _____
6. Which planet has the shortest day? _____
7. Which planet is closest in size to the earth? _____
8. Which planet has a length of day closest to the earth's? _____

What Planet Am I?

A game your students are sure to enjoy is "What Planet Am I?" In this game a student collects facts concerning a certain planet and uses them as questions. The student who correctly answers the question(s) becomes the next planet. The following questions can be used as examples:

1. _____ I am the planet nearest the sun.
2. _____ I am the largest planet.
3. _____ I am the planet named after the Roman god of the sea.
4. _____ I am the smallest of all planets.
5. _____ I am the third planet from the sun.
6. _____ I am known as the red planet.
7. _____ I rotate in a direction opposite that of the other planets.
8. _____ I am the planet named after the Roman god of war.
9. _____ I am the planet most distant from the sun.
10. _____ I am an often studied planet with polar ice caps, and a year twice as long as an earth year.
11. _____ I am a planet with a large red spot.
12. _____ My rings make me one of the most beautiful of all planets.
13. _____ I am a planet with 13 moons or satellites.
14. _____ I was named after the Roman goddess of beauty.
15. _____ A year on my planet is 84 times as long as one on earth.
16. _____ I have two moons and am larger than the other planet with two moons.
17. _____ My surface is hard to see because I am covered by dense clouds, but scientists think I may have a rocky surface similar to the earth's.
18. _____ I am a planet of air, land and water with a great variety of plant and animal life.

Answer Key

Page 2: Electromagnetic Waves

1. b
2. a
3. a
4. b
5. frequency and length
6. hertz
7. angstroms
8. cosmic and gamma
9. radio wave
10. low; higher

Page 4: Tabulating Electromagnetic Waves

Top row: a. x-ray, i. radar, g. cosmic rays
Middle row: c. radio waves, b. microwaves, h. infrared waves
Bottom row: f. ultraviolet rays, d. visible light rays, e. gamma rays

Page 6: Questions on How We See

1. a. pupil
   b. iris
   c. cornea
   d. lens
   e. retina
   f. optic nerve
2. lens
3. retina
4. optic nerve
5. lens
6. brain
7. light
8. retina
9. no
10. cornea

Page 8: Tabulating Sounds

Top row: 90, 70, 0
Second row: 20, 120, 70
Third row: 110, 110, 80
Bottom row: 40 or 80, 30, 50

Page 10: Questions on How We Hear

1. a. outer ear or auricle
   b. auditory canal
   c. tympanum
   d. hammer
   e. anvil
   f. stirrup
   g. cochlea
   h. auditory nerve
2. auricle or outer ear
3. tympanum
4. hammer (malleus)
   anvil (incus)
   stirrup (stapes)
5. vibrating objects
6. auditory
7. brain
8. auricle
9. through the air
10. sensory cells in the cochlea

Page 17: Tabulating Earthquakes

Top row: 5, 2, 4 or 5
Middle row: 5, 7, 10
Bottom row: 4, 7, 6

Page 19: The Action of a Volcano

a. lava or magma
b. cone
c. heat and pressure of the earth
d. earth's crust

Page 25: Seacoast Warnings

Top to bottom:
7 (near gale)
8 (gale)
9 or 10
11 or 12

Page 26: Tabulating the Wind

Top row: 7, 9, 4
Middle row: 5 or 6, 8, 0
Bottom row: 12, 2, 10

Page 31: Changing Degrees

1. 38.3° Celsius
2. 203° Fahrenheit
3. 44.6° Fahrenheit
4. 20° Celsius
5. medical, cooking, inside or outside household, thermostat

Page 32: Air Pressure

Answer to question: The air was taking up the space in the beaker.

Page 33: Does Air Have Weight?

1. some of the air
2. water
3. partial vacuum
4. the air pressure (weight of the air) on the outside of the can

Page 38: Tabulating Time in the United States

9:00 p.m. in Los Angeles
5:00 p.m. in Chicago
4:04 a.m. in New Orleans
4:00 p.m. in Atlanta
9:15 a.m. in Philadelphia
2:30 p.m. in Charlotte
1:00 a.m. in Chicago

Page 40: How Clouds Are Named

Clockwise starting at 1 o'clock: altocirrus, cumulonimbus, nimbostratus, altocumulus, altostratus

Page 42: Tabulating the Clouds

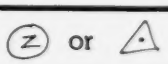
Top row: cumulus, cirrus, stratus
Middle row: cirrostratus, stratocumulus, altostratus

Bottom row: cirrocumulus, altocumulus, cumulonimbus

Page 43: Sky Symbols

Top to bottom
Symbol d
Symbol c
Symbol e
Symbol a
Symbol b

Page 47: Match the Word to the Weather Symbol

Word	Symbol
Isotherm	
Fog	
Cirrus cloud	
Warm front	
Thunderstorms	
Gale force winds	
Cold front	
55 to 65 mph winds	
Cumulo-nimbus or storm clouds	
Isobars indicating low pressure	
8 to 12 mph winds and a clear sky	
Sleet	

Page 48: Reading a Weather Map

1. 52°
2. south
3. 25 to 31 mph
4. Yes, 1006 millibars
5. stationary
6. warm
7. 68℉

Page 50: Questions on a Weather Map

1. Dallas
2. warm
3. Atlanta
4. 50℉
5. Cleveland, Boston, also Detroit
6. isotherm
7. isobars
8. fog
9. 13 to 18 mph
10. no
11. Detroit
12. Denver, Miami
13. stationary
14. 38℉
15. Dallas, 1122 millibars
16. Seattle and San Francisco
17. Cleveland
18. 64°
19. cold
20. Denver

Page 55: Tabulating Solar System Facts

1. Jupiter
2. Venus
3. Pluto
4. Mercury
5. Mercury, Venus, Pluto
6. Jupiter
7. Venus
8. Mars

Page 56: What Planet Am I?

1. Mercury
2. Jupiter
3. Neptune
4. Mercury
5. Earth
6. Mars
7. Venus
8. Mars
9. Pluto
10. Mars
11. Jupiter
12. Saturn
13. Jupiter
14. Venus
15. Uranus
16. Neptune
17. Venus
18. Earth

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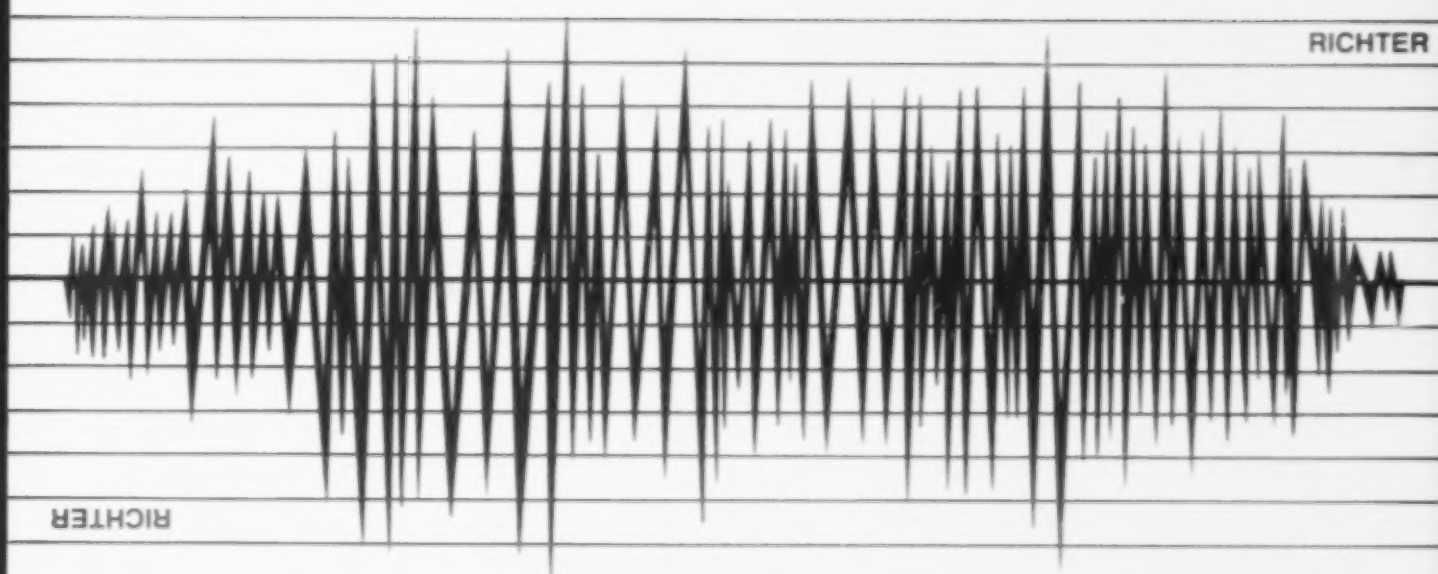
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